Strategic Environmental Assessment
of
Potential Exploration Rights Issuance For
Eastern Sable Island Bank, Western Banquereau Bank, the Gully Trough and the Eastern Scotian Slope

Canada - Nova Scotia Offshore Petroleum Board
Halifax, N.S.

August 2002

103-05415/

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1.0 Introduction and Scope

The Canada-Nova Scotia Offshore Petroleum Board (the Board) requires environmental assessment of all applications for activity authorization. All offshore petroleum activities, whether collecting seismic data, drilling a well, or installing a platform, must undergo an environmental assessment before being authorized. Although project-specific environmental assessment is an effective method of identifying and mitigating environmental effects, it can be enhanced by conducting strategic environmental assessments (SEA) prior to any individual projects being proposed, or even prior to when lands are first nominated or at the Call For Bids stage.

SEA is a broader, more proactive approach to environmental assessment. Typically applied to industrial sectors or broader geographic areas before individual projects are defined, it allows long-term planning and regional environmental concerns to be considered. Consideration of environmental factors at this early decision-making level can result in more environmentally sustainable policy-making, and lead to projects with improved environmental characteristics. At the very least, it will identify environmental concerns and constraints that can be incorporated into project design and future project-specific assessments.

This particular strategic environmental assessment considers the environmental implications of a possible decision by the Board to issue exploration rights for currently unlicenced areas of Eastern Sable Island Bank, Western Banquereau Bank, the Gully Trough and the Eastern Scotian Slope, including Shortland Canyon and Haldimand Canyon (see Figure 1). It provides an environmental overview of these unlicensed areas and considers the environmental effects of activities associated with exploration, namely geophysical (seismic) and exploratory drilling programs. In itself, an exploration licence does not allow any activities, but it gives the holder the right to make an application for an authorization to conduct an exploration activity.

The Gully Area of Interest (AOI), which is being evaluated under the *Oceans Act* as a candidate Marine Protected Area, is excluded from the study area. Recognizing the importance of the AOI, current Board policy prohibits oil and gas activity in the Sable Gully and Whale Sanctuary area until further notice. In addition to the buffer around the core area of the Sanctuary, which is already included in the existing boundary, the Board further requires that any seismic program proposed within 10 kilometres of the boundary be subject to an expanded individual assessment as described in the Board's *Environmental Assessment of Seismic Exploration On the Scotian Shelf* (Davis et al. 1998). The geographic proximity of potential exploration licences to the Gully AOI is a key consideration in this SEA.

The SEA has been prepared to assist the CNSOPB in decision-making related to potential land nominations in the study area and the subsequent Call for Bids, primarily by highlighting sensitive issues to be considered. By offering the document for public comment, it will also provide a mechanism for public input in advance of nominations or a Call for Bids, as well as input from agencies such as Fisheries and Oceans and Environment Canada. This SEA will be taken into account when reviewing nominations by industry to determine if the area is appropriate for hydrocarbon exploration, and if so, under what conditions. It is not a substitute for, but is complementary to, project-specific environmental assessment of geophysical, drilling or other proposed activities. Furthermore, this SEA is complementary to the generic environmental assessments prepared for seismic (Davis et al. 1998) and exploratory drilling (Thomson et al 2000), which describe in detail the potential environmental effects of seismic exploration and exploratory drilling on the marine environment.

The Board's approach to evaluating the environmental effects of activities associated with oil and gas exploration is thus a combination of strategic, generic and project-specific

environmental assessments. All environmental assessments conducted by the Board currently use the Valued Ecosystem Component approach as described in the Beanlands and Duinker 1993 publication *An Ecological Framework for Environmental Impact Assessment in Canada*. The significance of predicted effects is determined based on their magnitude, geographic scale, duration and likelihood of occurrence, as described in the generic environmental assessments.

1.1 Rights Management Process

Rights management in Nova Scotia's offshore is based on the *Canadian Petroleum Resources Act* model. As it relates to this SEA for possible issuance of exploration rights, the main components of the model include:

Crown Reserve Lands - Interests in Crown reserve lands (lands over which no interest has been issued) are awarded through a competitive bidding process. Details of the rights issuance process are described in the Canada-Nova Scotia Offshore Petroleum Board (the Board) publication *Guidelines On the Issuance Of Exploration Licences.*

Call For Nominations - Current Board policy relies on industry to nominate lands. Nominations can be submitted at anytime. However, the Board has established a semi-annual cycle for a June and December call for bids. The closing date to nominate lands for consideration in the June and December call for bids is March 31st and September 30th, respectively.

Call For Bids - Once land has been nominated, at the first Board meeting after the nomination closing date, the Board may commence the process to issue a Call for Bids. During this period, there is opportunity for public comment. The Call for Bids specifies:

- The type of interest to be issued (Exploration Licence, Significant Discovery Licence or Production Licence);
- The terms and conditions of the interest;
- The form and manner in which the bid is to be submitted;
- A closing date (minimum 120 days from issuance); and
- The sole criterion that the Board will apply in assessing bids submitted in response to the Call. All bids for Exploration Licences are evaluated based on total work expenditures, or the amount of money to be committed on exploration on the subject lands during period one of the term.

Exploration Licence (EL) – Exploration Licence (EL) – An EL is a licence issued to an operator giving them the exclusive right to make an application for an authorization to conduct exploration activities on the parcel of land. All activity and work within an EL has to receive the approval of the CNSOPB. An EL is issued for a nine year period, but a well must be drilled in the first five years for the licence to be extended to the full nine years.

Beyond the scope of this SEA, and depending on the outcome of exploration, further steps may include issuance of a Significant Discovery Licence (SDL) and a Production Licence (PL). The SDL is an intermediate interest designed to maintain an explorer's rights during the period between the first discovery and eventual production. Production rights are conferred by the issuance of a PL, which may be issued in respect of any portion of the offshore area subject to a commercial discovery. A commercial discovery is one that has demonstrated it contains reserves that will justify the investment of capital and effort to bring the discovery to production. Development would require a production licence and is therefore not contemplated in this SEA.

The SEA is used as input to Board decisions respecting whether a parcel of land nominated for exploration should be accepted at all (e.g. no Call for Bids), or if the area should be modified or have special conditions attached before proceeding to a Call for Bids.

2.0 Description of Environment

The acreage included in this Strategic Environmental Assessment (SEA) covers a range of ecological settings, from the shallow banks of the Scotian Shelf (less than 100 metres depth) to waters over 3500 metres in depth in the submarine canyons of the Scotian Slope. As shown in Figures 1 and 2, most of the SEA study area lies within a rectangle between latitudes 43° 30' N and 44° 30' N (about 114 kilometres) and between longitudes 58° 30' W and 59° 30' W (about 80 kilometres). It also includes the Shortland and Haldimand Canyon areas to the east. Several small adjoining unlicensed areas to the west and extends southward to 43°N between ELs 2411 and 2405. The study area excludes the Sable Gully Candidate Marine Protected Area (also referred to as the Gully Area Of Interest, or AOI). The total study area, including the Shortland and Haldimand Canyon "handle" and southern extension, but excluding the Gully AOI, is about 9000 square kilometres. Full Coordinates of the study area and Gully AOI are in Appendix A.

McGuire (1980) compiled an atlas of coastal and offshore resources for the Atlantic coast of Nova Scotia including Sable Island. The primary purpose of this document was to provide information in a map format that could be used as a tool in planning for and responding to oil spills.

The *Natural History of Nova Scotia* (Davis and Browne 1996) presents a general description of the Nova Scotia offshore region in which it is classified according to four districts – the Inner Shelf, the Middle Shelf, the Outer Shelf and the Scotian Slope. A Habitat Sensitivity Mapping System as well as work on marine habitat classifications are presently being compiled by the Department of Fisheries and Oceans (DFO).

Zwanenburg et al. (in press) prepared an overview of changes in the Scotian Shelf marine ecosystem over a period of several decades. Characteristics of the oceanographic environment, fish communities, fisheries, and marine mammal populations were explored. The document emphasized the importance of considering change over time in the marine environment and showed how changes can impact an ecosystem.

Breeze et al. (2002) have compiled a comprehensive ecological overview of the Scotian Shelf area. The report is divided into two sections – the first describing the marine environment and the second describing the marine life. The marine environment section summarizes the physical and oceanographic environment of the shelf, while the marine life section discusses the biological aspects of the area. The document states, "it is primarily intended to meet the general information needs of ocean planners and managers".

The SEA has been divided according to four geographical areas: Eastern Sable Island Bank, Western Banquereau Bank, the Gully Trough and the Eastern Scotian Slope (including Shortland and Haldimand Canyons). A general location of the study area is shown in Figure 1 while Figure 2 presents a more detailed view.

Ecological characteristics of the four sub-areas vary from area to area and are described subsequent sections. Other characteristics are less variable. For example water quality is likely relatively consistent throughout the area. Key parameters essential to ecosystem function include major ions and pH, dissolved oxygen, suspended particulate matter, nutrients, trace

metals and temperature. Although there is limited data, based on the lack of pollution sources in the study area, it is reasonable to conclude that all parameters are well within requirements for marine aquatic life, and that water quality is generally very good.

The ambient acoustic environment of the study area is influenced by wind, shipping and surf noise. Above 500 Hz, ambient ocean noise is produced primarily by wind and sea state conditions. Below 500 Hz, ambient noise levels are strongly related to ship traffic both near and far.

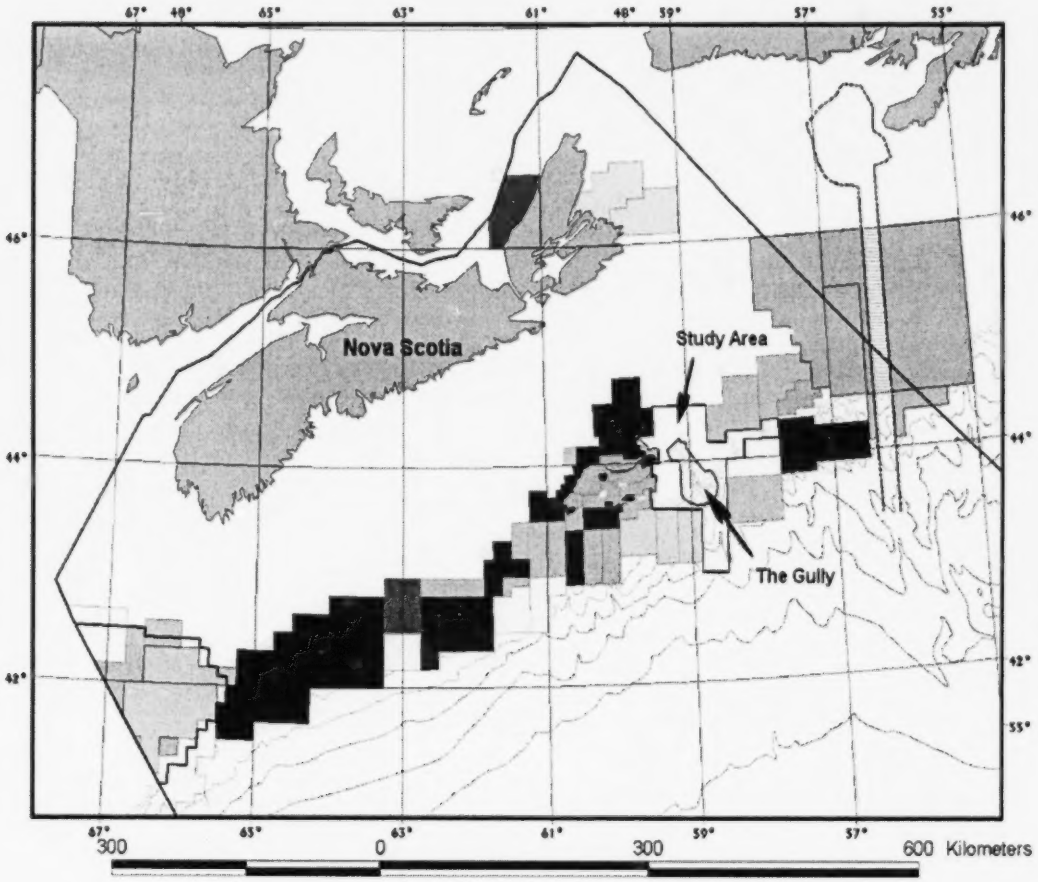

Figure 1 - Location of Study Area on the Scotian Shelf

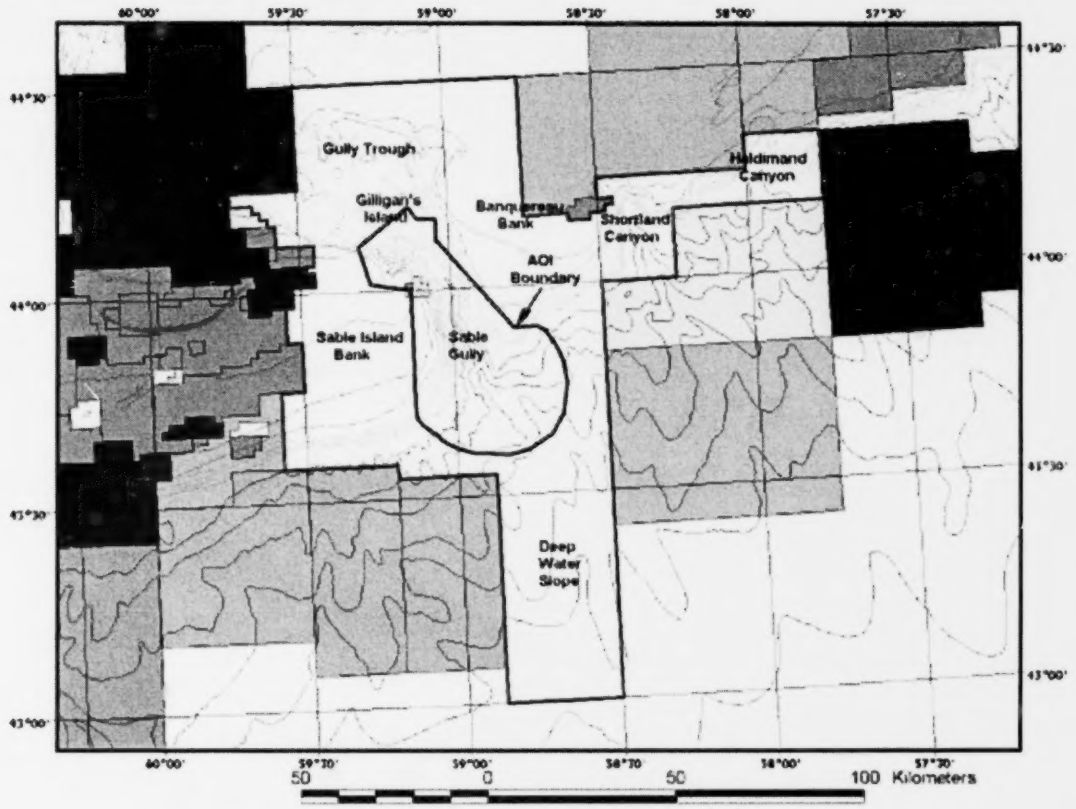

Figure 2 - Detailed Site Locations within the Study Area

(Note: see Appendix A for Study Area and Gully AOI coordinates)

2.1 Outer Eastern Scotian Shelf

The Scotian Shelf is a 700-kilometre section of the Continental Shelf, which is situated between the Laurentian Channel on the northeast and by Northeast Channel/Fundian Channel on the southwest. The Outer Shelf is characterized by several shallow banks separated by deep basins and channels. The main banks (Banquereau, Sable, Emerald, LaHave, Browns, and Georges) have depths of between 30 and 80 m) and are more or less flat topped. Scientific knowledge of the Shelf is better known than the Slope although there are still deficiencies in some areas, such as benthic organisms.

Surficial geology consists primarily of sand and gravel deposits of various sizes in water depths of less than 100 m while sand with silt and clay mixtures are found in the deeper areas. A long sand-ridge system stretches from Sable Island Bank to Banquereau Bank including Sable Island, and is perhaps the remnants of a barrier island system, now long submerged (Amos and Knoll 1987).

Circulation patterns on the Scotian Shelf primarily result from the convergence of three major ocean currents. The outflow from the Gulf of St. Lawrence through the Cabot Strait, the flow of shelf and offshore currents from the Labrador Sea and Shelf towards the equator, and the Gulf Stream currents from the offshore to the southwest are the major currents affecting the Scotian Shelf and adjacent waters (Breeze et al. 2002). Modelling efforts indicate that areas of western Sable Island Bank and Browns Bank have partial gyres that encourage physical retention (Cong et al 1996, Hannah et al 2001). These retention areas are thought to be of biological importance for spawning.

Studies of phytoplankton on the Scotian shelf have shown high productivity. There are spring and fall blooms in offshore regions, with the easternmost part of the shelf showing an increasing concentration of chlorophyll through the late summer before peaking in fall. This bloom covers Misaine, Banquereau, and Middle Banks and the eastern end of Sable Island Bank with another bloom further west on Browns Bank (Breeze 2002).

Zooplankton research on the shelf has been focussed on the two most abundant species groups: copepods and euphausiids (krill). Zooplankton biomass was found to be high on Emerald Bank, Western Bank, and the east end of Sable Island Bank (O'Boyle et al. 1984). They also suggested that ocean currents may be related to the abundance of zooplankton on the banks. More research in this area is required.

The Outer Scotian Shelf is relatively important for finfish and invertebrate species. Within the study are, for example, the Gully and adjacent waters is an area of relatively high demersal finfish diversity relative to the eastern Scotian Shelf as a whole. There is as yet no evidence for any endemic demersal species of fish within the Gully, but this possibility should not be ruled out. There are high densities of redfish, squid, cod, witch flounder, white hake, and longfin hake in the Gully area relative to the remainder of the Eastern Scotian Shelf (DFO 1998, p.138). There is evidence that submarine canyons such as the Gully may have higher benthic invertebrate diversity than the adjacent shelf.

Although comprehensive studies of benthic populations on the Scotian shelf are lacking, the Sable Offshore Energy Project (MacLaren Plansearch 1996) identified six shallow water (less than 100 m) benthic species groups that are characteristic of the Eastern Scotian Shelf. These are: 1. sand dollar, ocean quahog, surf clam, and northern propeller clam; 2. dwarf tellin clam; 3. Arctic surfclam; 4. sea scallop; 5. horse mussel and brittlestar; 6. horse mussel and red algae. *The Natural History of Nova Scotia* (Davis and Browne 1996) divided the offshore area into eight naturally occurring geographic regions. Species that were characteristic of each of these regions was provided. Snelgrove (1999) has suggested that less than one percent of marine benthic species are known.

Commercial invertebrate species found on the Shelf banks include offshore lobster, snow crab, sea scallop, northern shrimp, squid and Arctic surfclam, northern stone crab , toad crab, Jonah crab, rock crab, Iceland scallop, northern propellerclam, and ocean quahaug. Finfish species include cod, haddock, pollock, Atlantic halibut, white hake, silver hake, herring as well as several species of flounder and skate. Most of the finfish species that are fished commercially also spawn on the Scotian Shelf. Sable Island Bank also serves as a key nursery ground for cod and haddock (See Section 2.3.1). There are also numerous non-commercial species present on the Shelf Banks, many of which are prey for the commercial species (e.g. sand lance).

Marine mammals found on the Scotian Shelf belong to two taxonomic groups: the cetaceans a group that includes whales, dolphins and porpoises, and the pinnipeds, a group that includes

seals (Breeze et al. 2002). The most common species include sperm, northern bottlenose, northern right, humpback, blue, fin, sei, minke and long-finned pilot whales, short beaked common, bottlenose and Atlantic white-sided dolphins, harbour porpoises, harbour and grey seals (More detailed information is contained in Section 2.3.2).

Pelagic seabirds are found over a wide area on the Scotian Shelf throughout the year and are comprised of mainly shearwaters and storms petrels during the summer, and alcids and fulmers during the winter (for details see section 2.3.3).

2.1.1 Sable Island Bank

Sable Island Bank is one of a series of large, shallow banks that make up the outer Scotian Shelf. The bank is influenced by cool, coastal water and warm, saltier slope water, as well as tides and offshore currents. Sand and gravel make up the surficial geology of the Bank, with sand predominating (Amos and Nadeau 1988).

From analysis of multibeam bathymetry imagery, Fader and Strang (2002) identified nine major feeder canyons or channels on the west flank of the Gully incised into Sable Island Bank. It was implied that sand on the bank may be in active transport moving from the south to northeast and entering the upper feeder canyons of the Gully, as well as north to south movement into lower feeder canyons. There are indications that other materials also move off the bank into the canyon, e.g., suspended organic material, supporting productivity within the Gully. There is evidence from bedforms of transport of suspended organics and perhaps sediments from the north (trough) into the Gully.

In its 1983 environmental impact statement for the Venture project, Mobil Oil identified a particular benthic community, the sand dollar assemblage, associated with this sand habitat. It consists of sand dollars, ocean quahogs, surf clams and northern propeller clams. Sea stars, sea cucumbers and crab are also found in that area. In coarser sediments, horse mussels, sea scallop, brittlestar, lobster and toad crab occur (Davis and Browne 1996). A more recent and complete listing of known benthos on the Sable Island Bank can be found in Breeze et al. (2002) and the Environmental Impact Statement submitted for the Deep Panuke Offshore Gas Development. (PanCanadian Energy, 2002)

Fish and invertebrates can be found over the entire bank. An irregular counter-clockwise gyre is believed to operate on the bank, allowing for retention of nutrients and fish larvae, as well as floating marine debris (DFO 1998a, Lock et al 1994). Sable Island Bank is an important spawning area for many species of fish, including haddock, Atlantic cod, silver hake, white hake, winter flounder, yellowtail flounder, and herring. Due to depletion of stocks, few fisheries are currently carried out in the immediate area except for scallop and snow crab (see section 2.3.1 for more details). There are some minor holes north of Sable Island which are actively fished for northern shrimp.

The Sable Offshore Energy Project production sites are on Sable Island Bank. The marine environment of the bank is described in more detail in the SOEP Environmental Impact Statement (MacLaren Plansearch 1996).

2.1.2 Banquereau Bank

Similar to Sable Island Bank, Banquereau Bank is a large shallow bank situated on the outer Scotian Shelf. The surficial geology is comprised of sand and gravel with smaller amounts of gravel present (Amos and Nadeau 1988). Unlike Sable Island Bank, there are no present-day Gully feeder canyons that extend to this region (Fader and Strang 2002), although organic matter and very fine suspended sediments are thought to move off the bank into canyons, driven by bottom currents. The northern edges of the Bank have many steep sided hanging valleys formed by glacier meltwater running over their edges. These extend onto the bank under the cover of surface sediments and are called tunnel valleys (Davis and Browne 1996).

Benthic fauna is largely comprised of sand dollars, ocean quahogs, surf clams, sea scallops, Icelandic scallops, horse mussels and brittlestars. Species that are known to spawn on Banquereau Bank include cod, herring, winter and thorny skate as well as Arctic surfclam and snow crab. At present, commercial fisheries include Arctic surfclams, snow crabs, witch flounder and Atlantic halibut. There are currently applications under review to develop directed fisheries for the northern propellerclam and ocean quahog on the Scotian Shelf. These species are currently caught and processed as a by-catch to the Arctic surfclam fishery on Banquereau Bank. Historically, this area has been important for cod and haddock fisheries that have been closed since 1993 due to stock depletion. Other stocks present include American plaice and yellowtail flounder. The latter are very tightly distributed near the southeast corner of the bank, and supported a fishery until 1996 when this component was fished out (Fowler and Stobo 2000). This area is also adjacent to the northern shrimp fishery at Misaine Hole located to the north.

2.1.3 Gully Trough including Gilligan's Island

The Gully Trough is situated between Sable Island Bank and Banquereau Bank at the northern edge of the Sable Gully, with bathymetric linkages running for 100 kilometres to the north and northwest (GTA Consultants 1999) and is generally less than 300 metres in depth (Fader et al.1998). A plateau known as Gilligan's Island is located within the Trough with depths of 100 to 200 metres (see Figure 2).

The surficial geology in the trough, and in particular on Gilligan's Island, is different than adjacent banks, with mixed habitats that are more complex (Fader and Strang 2002, in Gordon and Fenton, 2002). The Gilligan's Island area has the highest benthic diversity of all studies in the Gully Region. Many fish species migrate between this area and the banks in summer and back into deeper water in winter. Fish distribution is mostly influenced by depth, water temperature and seasonal migratory and breeding behaviour patterns. Historically, the Gully Trough has been an important commercial fishing area. Species harvested include cod, haddock, and pollock although there is presently a moratorium on groundfish in this area. Important invertebrate species harvested in this region include squid and shrimp. Snow crab has also been caught in experimental fishing (GTA Consultants 1999). Observations of sperm whales and blue whales have been recorded in this area (Whitehead et al.1992, Whitehead et al.1998).

2.2 Scotian Slope

The Scotian Slope encompasses a large offshore area extending from the outer boundary of the Scotian Shelf (at a depth of approximately 200 metres) to the political and resource management boundaries at depths of between 4,000 and 5,000 metres. Scientific knowledge

for most areas of the Scotian Slope is lacking in many aspects. With the exception of the Gully area, no comprehensive studies have been conducted to date. Due to a lack of systematic surveys of seabirds, sea turtles and marine mammals, there is a knowledge gap with respect to information on abundance and distribution. As well, information regarding primary productivity, zooplankton and benthic invertebrates is scarce.

Although few detailed surveys of specific areas have been carried out, there have been several geological studies (Piper et al.1985) and broader environmental assessments of seismic exploration and exploratory well drilling on the Scotian Shelf and Slope (Davis et al. 1998; Thomson et al. 2000). Studies of the Halifax line and the Louisburg line have included stations on the slope (Mills and Fournier 1979); trawl surveys have been carried out on the Slope to examine the status of commercial fish species (Strong and Henke 1995); and research on specific species has also been conducted on the Slope. Still, our knowledge of the Slope habitats is quite general and lacks detailed descriptions of specific areas.

The surficial geology is somewhat varied, with sediments slumped along the shelf break in certain locations and exposed outcrops and scarp features in other localities (see Piper 1991 for details). While sand, mud, silty clay, gravel, boulders, and fine mineral particles all occur, the Sambro Sand unit (sand and silty mud) is the predominant type in water depths of less than 600 metres. Exposed bedrock can be found in steeper areas of the Slope. At depths of about 600 to 3000 metres, sequences of mud and silts prevail, interspersed with several sandier channels. At depths greater than 3000 metres, mud and silt with some sand deposits is the dominant material type on the eastern Slope.

The eroded slope would likely include rock outcrops providing appropriate substrate for sponges and corals, since the documented surficial geology is contiguous with areas with a greater number of records of deep sea corals. Deep sea corals have been reported in Shortland and Haldimand Canyons (Breeze et al. 1997).

Patterns of circulation in the Gully suggest it may play an important role in two ways: (1) in the localized retention of materials and (2) in the larger scale transport of materials onto and off the shelf (DFO 1998a).

Because of the variety of sediment types and the range of depths (from 200 to 5000 metres) the Scotian Slope has the potential to provide habitat to a diversity of marine benthos. Although comprehensive studies are lacking, work done for the Sable Offshore Energy Project characterized the deep water benthic communities of the Scotian Slope as dominated by a brittlestar *Ophiura* sp. with other echinoderms, shrimp, snow crab, sea pens, olychaetes and anemones also occurring (MacLaren Plansearch 1996). Much of this was based on the Environmental Impact Statement for the Venture Project (Mobil Oil 1983).

Generally, Slope areas have been shown to support a relatively high biodiversity. The Slope of the Continental Shelf is considered to start at about the 200-metre isobath. At these depths, near the edge of the shelf, the Slope is a highly biologically productive area because of the exchange of shelf water with slope water from the Gulf Stream. Tidal and current processes produce areas of upwelling at the shelf break, which bring nutrient-rich waters from below to the surface. The direct result of this phenomenon is an increased phytoplankton production and concentrations of zooplankton, providing a rich source of food for fish and other marine species. Whales migrate and feed along the slope; fish move off the shelf and down the slope to find preferred oceanographic conditions (see sections 2.3.1 and 2.3.2 for more details). Sea turtles likely travel over parts of the continental shelf slope in the summer months, especially in the warm waters of the Gulf Stream (CNSOPB 2000).

Pelagic seabirds are found year-round near the shelf break and are comprised of mainly shearwaters and storms petrels during the summer and alcids and fulmers during the winter (for details see section 2.3.3).

The concentration of certain fisheries, such as redfish and halibut, along the shelf edge shows the importance of this ecosystem for those species. Productivity decreases with increased distance from the shelf edge (Davis and Browne 1996).

Studies of the fish of the Scotian Slope have placed fish within various assemblages (for an overview see Mahon et al. 1998). In the shallower slope waters, redfish predominate. Other fish occurring at these depths are the white, red, and silver hake, American plaice, wolfish, winter skate, witch flounder, and Atlantic argentine (Markle et al. 1988). Fish more characteristic of slope waters deeper than 800 metres include roundnose grenadier, the slatjaw cutthroat eel, and dogfish (Markle et al. 1988). Marlin-spike and longfin hake are also found in deeper waters off Nova Scotia (Mahon et al. 1998). Other pelagic species found in Slope waters are swordfish as well as porbeagle, mako and blue shark. Zwanenburg (1998) grouped the demersal fish found at all depths in the vicinity of the Gully according to the depths they were most commonly caught by bottom trawl surveys. The most abundant species at depths between 180 and 360 metres were pollock, witch flounder, monkfish, silver and white hake; species most frequent between 360 and 900 metres were redfish (sp.), Atlantic halibut, and longfin hake; the most common species at or below 900 metres included roughhead grenadier (*Macrourus berglax*), black dogfish (*Centroscyllium fabicii*), and Portuguese shark (*Centoscymnus coelolpiš*); beyond 1800 metres longnose chimera (*Hydrolagus affinis*) become most abundant followed by blue hake (*Antimora rostrata*) and Portuguese shark.

Commercial fisheries presently conducted on this portion of the Scotian Slope include halibut, redfish, silver hake, tuna (albacore, bigeye, yellowfin), swordfish, porbeagle and mako shark. Some deep sea corals have also been reported by fisherman in this area (see section 2.3.1 for more details). Pohle et al. (1992) prepared a report that reviewed deepwater species which have the potential to become commercially exploitable (see section 4.2.1).

The slope and abyssal plain has a very high diversity of mesopelagic species. Over 200 species have been identified in water depths ranging from 1000 to 4000 metres with Mycophids (lanternfish) being the dominant family making up about 30% of the species composition (Themelis 1996, Halliday and Themelis 1998).

2.2.1 Shortland and Haldimand Canyons

To date, no detailed studies have been carried out on the two submarine canyons within the study area, Shortland Canyon and Haldimand Canyon (see Figure 2). The Gully is the only submarine canyon on the Canadian East Coast that has been investigated to any extent (Harrison and Fenton 1998, Gordon and Fenton 2002).

Although Shortland and Haldimand are smaller than the Gully the basic characteristics are likely the same. Both are on the order of half the size of the Gully, but are still relatively large features. Furthermore, canyons along the margin of the continental shelf off the eastern U.S. have also been extensively studied. They have been described as "unique biological habitats". Like the submarine canyons of the Scotian Shelf, they indent a relatively broad continental shelf and have a variety of sediments and diverse habitats. However, there have been no studies carried out on a similar scale here.

A conference on submarine canyons found off the northeastern coast of the U.S. looked at all the previous studies undertaken on those canyons (Walcoff & Associates, Inc. 1989). Some of the key findings from the studies of canyons along the U.S. Northeast continental shelf include:

- Canyons are more energetic than the adjacent continental slope. High amplitude tidal currents are found.
- Canyons have more complex topography than the adjacent continental slope.
- The canyon provides a channel for a flow of sediments from the continental shelf. Frequent resuspension of fine-grained sediments, at least at some depths.
- Higher fluxes of resuspended sediment than the adjacent shelf or slope (this has implications for dissolved contaminants in seawater).
- Canyons enclosed on three sides by the shelf are more likely to be impacted by drilling on the shelf, on canyon rims, and in uppermost parts of the canyon.
- Species diversity and abundance are greater in canyons than in non-canyon areas at comparable depths. Habitat diversity on a scale of a few metres to several kilometres leads to species diversity.
- There are major differences between the fauna of a canyon and those of the adjacent slope (thought to be caused by substrate and current differences). There is a higher diversity of megafauna due to a greater number/diversity of sessile filter feeders than the adjacent slope.

Documentation on submarine canyons that indent Continental Shelf Slopes has increasingly shown them to be sites with a range of habitats and diverse faunal communities when compared to adjacent Slope areas (Hecker et al. 1980, Vetter and Dayton 1998). Hecker and Blechschmidt (1980) found canyons to offer unique habitats for their faunal constituents. Harding (1998) suggests that there is a greater availability of nutrients in submarine canyons due to deposition of organic matter on continental slopes and patterns of water circulation in canyons.

Benthic studies of the Gully area have recently been carried out. Kostylev (2002) characterized the epibenthic communities of the Gully according to depth and identified seven assemblages of co-occurring species. Hard substrate areas were found to support the greatest number of megafauna and seemed to be important in supporting biodiversity. Hargrave and Hawkins (2002) found that the types and biomass of benthic epifauna communities that form on the heterogeneous substrates of the Gully are in part related to the amount of hard surface available for attachment and the supply of particulate matter used as food by these filter and deposit-feeding organisms.

Recent research on whale populations in the area has discovered that Shortland and Haldimand Canyons are important to the bottlenose whale population that also inhabits the Gully (Whitehead and Wimmer 2002). (More detailed information is contained in Section 2.3.2).

2.2.2 Deepwater Slope (Scotian Rise)

The deepwater slope, also known as the Scotian Rise, is probably the least studied area of the Nova Scotian offshore. The area extends from a depth of about 2000 metres to the abyssal plain located about 5000 metres below the surface (Breeze et al. 2002). Depths within the study area (southeast of the Sable Gully) range between the 2500 metre and 4000 metre isobaths (see Figure 2).

In general, the surficial geology of this region is comprised mainly of mud and silt with some sand deposits (Piper 1991). Deepwater sediments are covered with a thin layer of pelagic or

hemipelagic sediment which includes fine material particles and the shells and spicules of marine organisms, for example *Radiolaria* (Davis and Browne 1996). The area is subject to relatively high naturally occurring seismic activity with earthquakes of up to magnitude 6.0 having been recorded. (Davis and Browne 1996).

The Geological Survey of Canada (GSC) has carried out two seismic reflection surveys over portions of the study area (Campbell 2000). These surveys revealed the seabed to be well stratified but eroded with areas of steep slope. A ten kilometre section near the eastern boundary was classified as a debris flow with a smooth upper surface. Piper et al (1999) found the distribution and age of these debris flow deposits on the Rise to be correlated with sediment failures on the Slope and were as old as the mid-Pliocene Age. Unfortunately, coring samples recently collected by the GSC from this area have not been processed to date (Campbell 2002).

Five surficial geology zones for the Annapolis Block (about 40 kilometres west of the study area) have been identified (Jacques Whitford Limited (2001). Four of these five zones lie on the Scotian Slope and are presumed to have characteristics similar to the study area. The zones are described as follows: silty sand with minor pebbles and shell debris (canyon heads), sandy silt with minor gravel (isolated crested ridges), Holocene silts and clays (Slope), and silty sand (minor channels). The region is dominated by Holocene silt and clay which comprise 86 per cent of the area.

The deepwater area near the foot of the slope is considered to be clear water derived primarily from the Labrador Current moving along the bottom in a west-southwest direction (Davis and Browne 1996). At the HEBBLE site (see below) the seabed is characterized by fast currents, high concentrations of sediment and grooved mud beds which are associated with erosion and deposition from "benthic storms". These storms are thought to be caused when strong currents pass over the sediment deposits (Hollister and Novell 1991). The distinct bottom boundary layer present at the HEBBLE site is a strip about 100 kilometres wide and is thought to be part of a continuous ribbon or filament found on the continental margin near its base extending eastward to about 50° W and westward to about 72° W. Current meter records indicate that this cold filament of water flows toward the Equator embedded in the overlying fluid running at about 10 cm/s (Hollister and Novell 1991).

At present, little is known of the benthic communities of the Deepwater Slope (Scotian Rise) with a few exceptions. One of these is the High Energy Benthic Boundary Layer Experiment (HEBBLE) site which is located outside the study area located at 40° 27'N, 62° 20'W in depths of about 4800 metres. The abundance of numerous benthic organisms at this site, including polychaetes, bivalves, tanaids, and isopods was much greater than expected for the depth (for more details see section 2.3.4). Although the HEBBLE site is situated approximately 350 kilometres southwest of the study area, the benthic communities may have some similarities, particularly those located near the 4000 metre isobath. Grassle and Maciolek (1992) examined deep-sea benthic communities of the continental slope and rise and found that species diversity changed very little with distance along a 180 kilometre transect at a depth of 2100 metres.

Jacques Whitford Limited (2001) prepared a report for Marathon Canada Limited which characterized the benthic habitat of the Annapolis Block (Nova Scotian Exploration Licence 2377). Three primary benthic habitat types were identified: 1. Ophuroid and Burrowing Anemone Habitat, 2. Epilithic Anemone, Sponges and Bivalves Habitat, 3. Ophuroid, Coral, Sponges and Epilithic Anemone Habitat (see section 2.3.4). This site lies approximately 40 kilometres to the west of the study area (water depths of 370 -3250 metres) and is presumed to have similar benthic characteristics. Benthic fauna appeared to be generally low in abundance and no significant coral development was observed in this area.

Nekton (free swimming animals) of the deepwater area can be grouped into three vertical zoned communities: epipelagic, mesopelagic, and bathypelagic. The epipelagic (top) community includes surface-swimming molluscs (Janthina and Argonauta), cnidarians (Vella and Physalia), and fish (swordfish and flying fish). The mesopelagic (middle) group is characterized by a diurnal vertical migration of several hundred metres. This group is comprised of crustaceans (shrimp and amphipods), cephalopods (squid and pelagic octopus), and fish such as lanternfish, viperfish and hatchetfish. The bathymetric (bottom) community lives in close association with the ocean bottom and include the commercially important fish species roundnose grenadier that inhabit depths as far as 2500 metres (Davis and Browne 1996). Halliday and Themelis (1998) found over 200 mesopelagic species at various locations on the Scotian Slope (depths 1000 – 4000 metres) with lanternfish (Mytophids) being the dominant species. Only a small fraction of the mesopelagic fishes is commonly found in the vicinity of the Gully and none are endemic (Halliday et al. 1995).

Pohle et al. (1992) examined the deepwater fish and invertebrates found off Nova Scotia waters. Detailed descriptions of five fish species considered to have the highest potential for commercial development were provided: Atlantic saury, blue hake, black scabbard fish, black dogfish, and orange roughy (see section 4.2.1). In a study of demersal fish in the vicinity of the Gully, Zwanenburg (1998) found the most abundant species beyond 1800 metres were longnose chimera (*Hydrolagus affinis*) followed by blue hake (*Antimora rostrata*) and Portuguese shark (see section 2.2). The author states that the Gully represents only a small portion of the slope of the Scotian Shelf and it is likely that this composition is indistinguishable from the species composition from adjacent areas of the slope. To date, no surveys have been carried out focusing on the deepwater fish populations within the study area.

Commercial fisheries in this area is presently limited to the large pelagic species. These include swordfish, tuna (bluefin, albacore, yellowtail, and big-eye) as well as shark (porbeagle, mako and blue).

Several whale species including sperm and northern bottlenose whales are found in the deepwater slope on a regular basis. Whitehead et al (1992) found that mature sperm whales could be found in depths up to 1500 metres. Bottlenose whales are regularly found at depths of more than 1000 metres (Whitehead and Wimmer 2002, Hooker et al. 2002) This species frequent the Gully and nearby areas and have never been observed in water less than 800 metres in depth (Whitehead et al. 1997).

2.3 Valued Ecosystem Components

In the context of an environmental assessment, an interaction is defined as a time and/or a place where project activities come into contact with an environmental component (Thomson et al 2000). It is beyond the scope of this document to depict all characteristics of the marine environment, although a general overview is provided above. To focus the review and to assist with the strategic environmental assessment of these parcels, several Valued Ecosystem Components (VECs) have been selected. Beanlands and Duinker (1983) defined VECs as the environmental attributes or components identified during a social scoping exercise. These may be determined based on perceived public concerns related to social, cultural, economic or aesthetic values as well as the scientific concerns of the professional community. Valued Ecosystem Components include rare or threatened species or habitats; species or habitats that are unique to an area, or are valued for their aesthetic properties; and species that are harvested by people. When describing VECs it is important to insure that primary forage species are also identified.

The VECs selected for this SEA are based on those used in the generic assessments of exploration drilling (Thompson et al., 2000) and seismic (Davis et al., 1998). Those, in turn, were based on the EIS for the Sable Offshore Energy Project and during workshop and agency consultations. These include:

- Fish and invertebrates of commercial importance, including fish and invertebrate larvae;
- Marine mammals;
- Marine birds;
- Benthic invertebrates (bottom dwelling organisms);
- Sea turtles;
- Forage species for fish, mammals, and birds;
- Rare, threatened, or endangered species
- Special areas:
    - Sable Island,
    - The Gully, and
    - Shortland and Haldimand Canyons.

Habitats important on a seasonal basis to VECs are identified, such as fish spawning and fish nursery areas, where known. Other ecosystem components are mentioned in relation to their importance to the valued ecosystem components.

Fisheries are considered a valued human activity within the ecosystem and are discussed in a separate section (2.3.1). Other human activities are also discussed in section 4.0.

2.3.1 Fish and Invertebrates of Commercial Importance, Including Larvae

Table 1 lists spawning times and habitat locations for important commercial species that are either in or near the study area. Non-commercial species may play important roles for commercially used fish and invertebrates; however, data is lacking for most of these species on the Scotian Shelf and little information about them is included in this review (see section 2.3.6). The demersal species included in this overview are Atlantic cod, Atlantic halibut, haddock, pollock, redfish (sp.), yellowtail flounder, winter flounder, witch flounder, American plaice, wolffish, silver hake, white hake, cusk and skate (sp.). The pelagic species included are Atlantic herring, Atlantic mackerel, bluefin, albacore, bigeye, and yellowtail tuna, swordfish, spiny dogfish, porbeagle, and blue and mako shark. Commercially important invertebrates found within the area consist of snow crab, Arctic surfclam and northern shrimp. Although not listed, some experimental fishing for Jonah and stone crab has been carried out in the area. Rock crabs are in the area in some abundance and have been fished commercially elsewhere. Toad crabs are of interest elsewhere.

The information on spawning times and locations is from the numerous sources listed at the bottom of Table 1. The times given may be overly broad due to overlapping or inconsistent time periods provided by these sources. As well, locations of spawning and the distribution of ichthyoplankton may change from year to year. Spawning occurs almost year-round on Sable Island Bank and for most of the year on the Scotian Slope. More species that are commercial spawn on Sable Island Bank than on the Slope. Fish eggs and larvae are generally found near the surface or through the water column; however, the eggs of herring attach to the bottom (Scott and Scott 1988). Other fish, such as redfish and sharks, release live young, while skates deposit eggs in capsules.

In order to stay in environments of their preferred temperature and salinity, many demersal fish live on the shallow banks in the summer and move to the deeper waters of the channels and saddles between the banks and the continental slope in the winter. Areas where concentrations of adult fish occur vary from year to year depending on the oceanographic environment.

Sable Island Bank is an important spawning and nursery area for many fish species (DFO 1997b, and O'Boyle et al. 1984). The bank is believed to have an occasional gyre which allows for larval retention. Although the "Haddock Box", which outside the study area on Western and Emerald Banks, is better known as a haddock nursery area, adjacent areas on Sable Island and Banquereau Banks are also important to young haddock. In some years, the area around Sable Island has a very high density of juvenile haddock (Kenchington 1998). The spawning period for cod appears to begin in September-October. Larvae are found in the area into November and December (Hanke et al 2000). Most of the offshore herring spawning takes place on central Sable Island Bank in late October (Harris and Stephenson 1999).

Table 1 Habitat & Life Stages of Fish and Invertebrate Species[1]

Species Common Name *Scientific Name*	**Spawning Within Study Area[2]**		**Areas of Concentration of Adults within Study Area**
	Period	**Location in Study Area**	
Demersal fish			
Atlantic Cod *(Gadus morhua)*	peaks in Nov. and through the winter; other peaks occur in February – June. Nov – Dec period is particularly important for this part of the shelf.	Sable Island Bank Banquereau Bank	Offshore Banks Bank (summer); upper part of the continental slope (winter). Variable depths and temperatures; generally less than 200 m, temp. of 2° to 10°C.
Atlantic Halibut *(Hippoglossus hippoglossus)*	February to May	At depths of 183 m or greater, location uncertain, likely slope area (including channels & canyons)	The edge of the continental shelf; some found north-eastern Sable Island Bank in the summer. More plentiful from 200 m to 500 m with younger fish in shallower water. Prefer water temperature near 5°C.

Haddock *(Melanogrammus aeglefinus)*	March to June	Sable Island Bank	Sable Island Bank, southwestern Banquereau and shelf edge in autumn. Juvenile haddock found over Sable Island bank and Banquereau.
Pollock *(Pollachius virens)*	late summer and fall	Sable Island Bank	Sable Island Bank; shelf break, especially areas near Laurentian Channel. Prefers depths to approx. 185 m.
Redfishes (sp.) *(Sebastes sp.)*	release live young from April to July	Shelf edge	Shelf edge and slope, Gully, edge of Laurentian channel, found from depths of 100 m to approx. 700 m. Prefer temperatures of 3 to 8°C.
Flounders: yellowtail *(Limanda ferruginea)* witch (*Glyptocephalus cynoglossus*) winter *(Pleuronectes americanus)* American plaice *(Hippoglossoides platessoides)*	 from April to early October, May/June peak May to October (July/August peak) March to July March to June	 Sable Island Bank (generally shoals) Records throughout Scotian Shelf and slope Sable Island Bank Sable Island Bank, some slope areas; generally depths less than 183 m.	 Sable Island Bank, generally from 37 m to 91 m (deeper in winter). Prefer temperatures of 2 to 12°C. Most common on continental shelf slope. Generally prefer depths of 50 m to 300 m (though found much deeper) and water temperatures of -1 to 11°C. Widespread at depths of less than 150 m. Throughout study area. Prefer depths of 73 m to 274 m, found at more than 700 m; prefer cooler temperatures (0 to 1.5°C).
Silver hake *(Merluccius bilinearis)*	June to September	Shoals of Sable Island Bank	Sable Island Bank (summer), shelf edge and slope area (winter and spring). Major concentrations at shelf edge in depths below 100 metres in spring, move to shallows to spawn in summer before moving back to shelf edge (Sigaev 1996). Juvenile silver hake found at edge of banks. Prefer water temperatures of 7 to 10°C.
White hake *(Urophycis tenuis)*	spring/early summer and late summer/early autumn	Slope area (uncertain), spawning areas and times not well understood	Slope of continental shelf, including slope area by Laurentian Channel. Prefer depths of 50 m to 400 m and water temperatures of 3 to 10°C.

Wolffish *(Anarhichas lupus)*	unknown	Reported near Sable Island	On continental shelf and slope. Prefer depths of 50 m to 150 m.
Skates: smooth *(Raja senta)* winter *(Raja ocellata)*	 unknown summer to autumn (uncertain)	 likely throughout study area Sable Island Bank	 Concentrations on the eastern shelf slope, near the Laurentian Channel. Can be found at all depths, prefer depths of less than 300 m. Banquereau Bank, Sable Island Bank . Found at all depths, prefer depths less than 300 m.
Pelagic Fish			
Atlantic Herring *(Clupea harengus)*	August to November	Sable Island Bank Banquereau Bank	Northern portions of Sable Island Bank, through to Gully trough area, Banquereau Bank.
Atlantic Mackerel *(Scomber scombrus)*	June to August	some spawning on shoals of Sable Island Bank	Migrate through Sable Island Bank. Some (few?) in slope area in winter. Overwinter in slope area south of Sable Island Bank and further along the slope to the southwest (see Studholme et al. 1999). More juveniles near Sable Island Bank than further south
Bluefin Tuna *(Thunnus thynnus)*	n/a[3]	n/a	Movements throughout the shelf and slope in late spring and summer months.
Swordfish *(Xiphias gladius)*	n/a	n/a	Shelf edge and Slope from May to November, not in area in winter. Prefer water temperatures above 8°C.
Porbeagle Shark *(Lamna nasus)*	n/a	n/a	Throughout study area from spring to fall. Prefer water depths of less than 370 m and water temperatures of less than 14°C.
Blue Shark *(Prionace glauce)*	n/a	n/a	Throughout study area from spring to fall. Prefer shallow water depths water temperatures of 7-16°C.
Mako Shark *(Ieurus oxyringus)*	n/a	n/a	Often occupy the same habitat as swordfish Prefer water depths of less than 150 m and water temperatures greater than 16°C.
Spiny Dogfish *(Squalus acanthias)*	n/a	n/a	Found in study area from spring to fall. Found in water depths up to 730 m and prefer water temperatures of 3-11°C.

Invertebrates			
Snow Crab *(Chionoecetes opilio)*	peak concentrations of larvae from mid-July to mid-September	larvae are dispersed over Shelf	Sable Island Bank, Banquereau Bank
Ocean Quahog *(Arctica islandica)*	Peak in July-September	where adults found	Found in sandy areas of offshore banks, especially Banquereau Bank and Sable Island Bank
Arctic Surfclam *(Mactromeris polynyma)*	Fall	Banquereau Bank	Banquereau Bank, mainly east of Shortland Canyon
Northern Shrimp *(Pandalus borealis)*	Release larvae in late winter and early spring	Occur mainly where adults are found	Mostly in deep holes and depressions of Louisbourg, Misaine, and Canso Holes located north of Banquereau Bank. Some found in the Gully Trough area.

Sources consulted include Breeze et al (2002), Davis et al. (1998), DFO Stock Status Reports (see list in references), Hanke et al. (2000), Thomson et al (2000), MacLaren Plansearch (1996), Neilson et al. (1988), Neilson and Perley (1996), O'Boyle et al. (1984), Scott (1983), Scott (1988), Scott and Scott (1988), GTA Consultants (1999).

[2] There are gaps in knowledge about spawning. Different time periods and locations may be given by different authors.
[3] n/a = believed not to occur in study area
[4] Unable to find spawning times or location in literature.

The following three tables present the spawning times listed earlier, arranged by geographical area and by month. Like Table 1, Tables 2, 3 and 4 are a simplification and do not address the subtleties of spawning times. Fish species listed in the same month may not be spawning at the same time due to yearly variations. Species with very uncertain spawning times or generalized locations are not included in these tables.

Table 2: Spawning Times, Sable Island Bank [1]

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cod												
Winter Flounder												
American Plaice												
Haddock												
Yellowtail Flounder												
Witch Flounder												
Silver Hake												
Herring												
Atlantic Mackerel												
Quahog												

Snow Crab												
Sea Scallop												

Table 3: Spawning Times, Scotian Slope [1]

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Atlantic Halibut												
Northern Shrimp												
Red Fish (live young)												
Witch Flounder												

Table 4: Spawning Times, Banquereau Bank [1]

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cod												
Herring												
Quahog												
Snow Crab												
Surf Clam												

[1] Sources consulted include the same references as Table 1.

Other Fish Habitat Considerations

Areas not identified in these tables may be important fish habitat, especially for juvenile fish. Auster et al. (1996) suggested that areas of the ocean bottom presenting more complex physical habitat, such as areas with boulders or with sessile benthic invertebrates, may be areas of high fish density. These areas have not been mapped on the Scotian Shelf (CNSOPB 2000).

2.3.2 Marine Mammals

There are whale and seal species present throughout most of the study area. Sable Island, the area immediately surrounding it, the continental shelf edge, and submarine canyons seem to be important for a large number of marine mammals. Data extrapolated from the north-eastern United States would suggest that the Scotian Slope, from depths of 200 metres to 1000 metres would be an area of high use by cetaceans, especially toothed whales (see Kenney and Winn 1986). There is considerable scientific interest in the area. Research conducted by Whitehead et al. (2002) found a proliferation of whales and dolphins along the 1000-metre depth contour off eastern North America.

2.3.2.1 Whales

Table 5 lists the cetaceans known to occur on the Scotian Shelf. As few records exist for some species such as Sowerby's beaked whale and the bottlenose dolphin, these species are listed as 'probable visitors' to the area. The habitat for whales may be greater than indicated since it

is based on sightings only, with no allowance for the amount (or lack) of research effort in an area. The *Environmental Impact Statement of the Sable Offshore Energy Project* (MacLaren Plansearch 1996) included a map of marine mammal distribution. The map was prepared from data collected before 1983 and may not reflect current distribution. The *Environmental Assessment of Exploration Drilling Off Nova Scotia* includes distribution maps of observations of marine mammals (Thomson Ltd. et al. 2000). An overview of whales on the Scotian Shelf (including tables and distribution maps) is provided by Breeze et al. (2002).

Most of the whales listed in Table 5 are found in many other areas besides the study area. However, the number and diversity of animals found in the waters near Sable Island suggest that this is an important area for marine mammals. Harrison and Fenton (1998) suggested that it could be the most important area on the Scotian Shelf for all marine mammals and Amirault (1995) suggested that it could be an area of global significance.

Several whales found in Nova Scotian waters are considered at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). COSEWIC (2000) lists the blue, fin, humpback, Sowerby's beaked, and northern bottlenose whales as species of special concern. The blue whale has recently been designated as endangered. The population of northern bottlenose whales inhabiting the Gully area has been estimated at approximately 130 animals (Gowans et al. 2000).

The Gully's population of northern bottlenose whales is an important reason that the area is under consideration as a marine protected area. The Gully is presently recognised as a whale sanctuary and is the core area for this population (Whitehead et al.1997, Hooker et al 1999); however, these whales have recently been observed using adjacent canyon areas (Shortland Canyon and Haldimand Canyon). Whitehead and Wimmer (2002) found considerable mixing of animals among the three canyons.

Table 5 Habitat within Study Area - Whales	
Toothed Whales (Odontoceti)	
Sperm Whale (Physeter macrocephalus)	Scotian Shelf edge, may be more common in submarine canyons (commonly sighted in the Gully area).
Northern Bottlenose Whale *(Hyperoodon ampullatus)*	Scotian Shelf slope (main habitat is the Gully). Recently observed in Shortland and Haldimand Canyons.
Short-beaked Common Dolphin *(Delphinus delphis)*	Throughout area in late summer. Prefer Scotian Shelf edge in waters above 5°C. Known to prefer rough topography and canyon habitats.
Striped Dolphin *(Stenella coeruleoalba)*	Throughout area in summer. Prefer deep water of Scotian shelf edge and warm (15°C) waters. Observed in the Gully area.
White-beaked Dolphin *(Lagenorhynchus albirostris)*	Often seen off the coast in the summer and likely to regularly use offshore areas. Probably more likely to be present in winter. Prefer cool waters
Atlantic White-sided Dolphin *(Lagenorhynchus acutus)*	Throughout area. Prefer waters deeper than 50 metres
Killer Whale *(Orcinus orca)*	Occasional visitor to area. Rarer visitor than white-beaked dolphin.
Long-finned Pilot Whale *(Globicephala melas)*	Found in cool waters including Scotian Shelf edge and canyon habitats.
Harbour Porpoise *(Phocoena phocoena)*	Occasional visitor to shallow waters of Scotian Shelf. Thought to regularly use the Scotian Shelf but few sightings.
Baleen Whales (Mysticeti)	
Northern Right Whale *(Eubalaena glacialis)*	May move through area in summer and fall.
Humpback Whale *(Megaptera novaengliae)*	Migrates through area in summer. Have been regularly sighted in the Gully.
Blue Whale *(Balaenoptera musculus)*	Occasional visitor to the area. Regularly seen in the Gully area in July & August.
Fin Whale *(Balaenoptera physalus)*	Sable Island Bank, continental slope. Have been sighted in the Gully region during summer.
Sei Whale *(Balaenoptera borealis)*	Migrates along the continental slope in spring and fall
Minke Whale *(Balaenoptera acutorostrata)*	Found throughout study area.

Source: Breeze et al. (2002), Whitehead et al (1998)

2.3.2.2 Seals

Table 6 lists the seals found on the Scotian Shelf. The pupping location is listed since the possible disturbance of seals during pupping was identified during the Sable Gas Projects panel hearings. There have been an increasing number of oil and gas industry related activities near Sable Island, the pupping location is in close proximity to the study area.

Table 6 Habitat within Study Area - Seals

Species	Pupping Location	Adult Habitat in Study Area
Grey Seal *(Halichoerus grypus)*	Sable Island, mid-December to late January	Throughout study area
Harbour Seal *(Phoca vitulina)*	Sable Island, mid-May to mid-June	Sable Island and surrounding area
Harp Seal *(Phoca groendlandica)*	n/a[1]	Juveniles on Sable Island and surrounding area
Hooded Seal *(Cystophora cristata)*	n/a	Juveniles on Sable Island and surrounding area
Ringed Seal *(Phoca hipsida)*	n/a	Occasional visitor to Sable Island

Sources: Whitehead et al. (1998), Beson (1998).
[1] n/a = not in study area

Sable Island is important for two breeding populations of seals: it has the world's single largest breeding population of grey seals and a much smaller number of breeding harbour seals (less than 50). This population represents about 70 % of grey seal pup production in eastern Canada (Mohn and Bowen 1996). Seals feed in the waters off Sable Island and in the Gully year-round, sand lance forming a particularly important part of their diet. Grey seals range farther than harbour seals. Harp, hooded and ringed seals are not usually observed in waters further south than Sable Island.

There are thousands of harbour seals found on the Canadian Atlantic Coast. However, the breeding population at Sable Island is the only offshore population. The number of seal pups born on Sable Island has declined since 1992 (Whitehead et al. 1998).

2.3.3 Marine Birds

The shallow fishing banks of the outer Scotian Shelf and the edge of the shelf are important areas for pelagic seabirds at all times of the year. Both Sable Island Bank and the Scotian Slope have high concentrations of seabirds year-round (see Strategic Assessment for Call for Bids NS98 - 2 for details of the location of pelagic seabirds, based on maps in Lock et al. 1994). Seabirds include summer and winter residents, as well as those migrating to other areas. The area north of Sable Island, where there is mixing of waters caused by a gyre on Sable Island Bank, is an area of consistently high seabird numbers (Lock 1998). The area of the western Gully also often has large numbers of seabirds present.

Because they spend much time on the surface of the water, pelagic diving birds are particularly vulnerable to oil spills, including dumped oil-polluted water. Pelagic birds also have small clutch sizes and would require a long time to recover from decreases in population (Lock et al. 1994). Table 7 lists pelagic birds known to occur in the study area and the time of year they are present.

Table 7 Known Seasonal Presence in Study Area – Marine Birds

Pelagic birds	**Summer**	**Winter**
Northern fulmar *(Fulmarus glacialis)*	no	yes
Shearwaters *(Puffinus sp.)*	yes	no
Leach's storm-petrel *(Oceanodroma leucorhoa)*	yes	?
Wilson's storm-petrel *(Oceanites oceanicus)*	yes	No
Northern Gannet *(Sula bassana)*	during migration (generally April/May and September/October)	
Red Phalarope *(Phalaropus fulicarius)*	during migration, common transient	
Pomarine Jaeger *(Stercorarius parasiticus)*	during migration and summer, uncommon transient	
Parasitic Jaeger *(Stercorarius parasiticus)*	during migration and summer, uncommon transient	
Long-tailed Jaeger *(Stercorarius longicaudus)*	during migration and the summer	
Great Skua *(Stercorarius skua)*	during migration and	

	the summer	
South Polar Skua *(Stercorarius maccormicki)*	during migration and the summer	
Thick-billed murre *(Uria lomvia)*	no	yes
Common murre *(Uria aalge)*	no	yes
Atlantic puffin *(Fratercula artica)*	?	yes
Razorbill *(Alca torda)*	?	yes
Dovekie *(Alle alle)*	No	yes
Black-legged Kittiwake *(Rissa tridactyla)*	Yes	yes

Source: Lock et al. (1994)

There have been increasing concerns about the cumulative effects of small amounts of oil released at sea on marine birds. Studies have shown that very small amounts of oil on its feathers can kill a seabird in the cool waters of the Scotian Shelf.

Gulls are also found in the offshore and are attracted to human activity such as drilling rigs, ships and fishing boats. They are considered less vulnerable to oiling than the species listed in Table 6.

2.3.4 Benthic Invertebrates (bottom dwelling organisms)

The benthic invertebrates of the Scotian Shelf provide habitat and food for other organisms living on the Scotian Shelf. The communities of deep water benthos off Nova Scotia are not well known. Some of the benthos of the offshore banks is described in section 2.1, while that of the shelf slope is described in section 2.2. A brief description of deepwater benthic communities can also be found in sections 2.2.1 and 2.2.2. The benthic invertebrates identified as VECs in this section are in addition to those commercial species already identified.

Sessile filter feeders such as corals and sponges offer habitat for other marine organisms. They are vulnerable to disturbances in the ocean bottom and increased sediment load in the water column and may thus be good indicators of disturbances of the marine environment (Hecker et al. 1980, Breeze et al. 1997 and Rogers 1999). Scleractinians (true or stony corals), gorgonaceans (horny corals) and alcyonaceans (soft corals) are found in Nova Scotia's waters. The soft corals seem to be somewhat widely distributed in both deep and shallow waters. However, the deep-water scleractinian and gorgonian species may have only a localized distribution. Many of the species found in our waters need hard substrate on which to settle; smaller species such as the gorgonian *Acanella arbuscula* anchor in soft substrate and the solitary scleractinians of the genus Flabellum live freely on muddy sand.

Although submarine canyons and the edges of channels have been identified as key locations for coral on the Scotian Shelf, coral has also been collected along the slope (Breeze et al.

1997). A specimen of the deep-sea coral *Paramuricea grandis* was collected along the continental slope between Shortland and Haldimand Canyons (Breeze et al. 1997).

Corals may have highly localized distribution and may therefore be vulnerable to disturbance (Consensus Statement 2000). There has been increasing interest in deep-sea corals worldwide. The first international conference on deep sea corals was held in Halifax during the summer of 2000 and attended by scientist from around the world. Scientists at the conference developed a consensus statement on the conservation of deep-sea corals. Because of their slow growth, longevity, and role in providing habitat, deep-water coral conservation is regarded internationally as a high priority (Consensus Statement 2000).

Within the study area, several coral species have been recorded in Shortland Canyon and Haldimand Canyon although no detailed studies have been carried out in this region to date. DFO and university researchers are working to determine areas where corals are found and the species with which they are associated on the Scotian Shelf (Breeze 2002). Jacques Whitford Limited (2001) identified a few isolated areas of coral growth within the Annapolis Exploration Block (see below). However, no significant coral development was observed in this area.

Benthic invertebrates of the deepwater slope are not well known with few detailed studies having been carried out to date. One significant exception is the High Energy Benthic Boundary Layer Experiment (HEBBLE) located on the Scotian Rise at 40° 27'N, 62° 20'W in depths of about 4800 metres (McCave et al. 1978). Researchers studied this site over several years and compiled reports on sediments, biological activity, relationship of the benthos with sediments, benthic communities, and responses of benthic communities to disturbance (Discoll and Tucholke 1983, Aller and Aller 1986, Carman et al. 1987, Aller 1989, Thistle et al 1991). The abundance of numerous benthic organisms at this site, including polychaetes, bivalves, tanaids, and isopods was much greater than expected for the depth. Numbers of most species were consistent over time and appeared to be unaffected by periods of strong near-bottom flow that characterize the site. The exceptions to this were nematodes and harpacticoids which were not as abundant and decreased in numbers following a benthic storm. (Thistle et al 1991). See section 2.2.2.

The benthic habitat of the Annapolis Block (Nova Scotian Exploration Licence 2377) was studied by Jacques Whitford Limited (2001) in a report for Marathon Canada Limited. Identification was based primarily on the physical characteristics of the surface sediments which were verified by samples collected from the surface. The results characterized three primary benthic habitat types described as follows: 1. Ophuroid and Burrowing Anemone Habitat – comprised mainly of brittlestars, burrowing anemones, small molluscs, bivalves, and polychaetes. 2. Epilithic Anemone, Sponges and Bivalves Habitat – Comprised mainly of epilithic anemones and encrusting sponges; shell debris from bivalves was a component in sediment samples. 3. Ophuroid, Coral, Sponges and Epilithic Anemone Habitat – contained a few isolated coral growth areas; the following species were identified: *Acanthogorgia* spp., *Acanella arbusscula* and *Keratoisis ornate* (horny corals), *Anthomastus grandiflorus* (soft coral) and *Flabellum* spp. (stony coral). The most dominant habitat type was found to be the Ophuroid and Burrowing Anemone Habitat present in the Holocene silts and clays.

Other benthic species of importance are discussed elsewhere in the SEA, in relation to other VECs such as commercial fisheries species.

2.3.5 Turtles

Three species of sea turtles are found on the Scotian Shelf at some point in their life cycle (Table 8). All are considered uncommon and are listed as endangered (Atlantic leatherback and Kemp's ridley) or threatened (loggerhead) by either COSEWIC, or by the United States National Marine Fisheries Service (Thomson Ltd. et al. 2000). The Scotian Shelf is used as a foraging area by adult leatherback and juvenile loggerhead turtles and is occasionally visited by Kemp's ridley turtles (Breeze 2002).

Table 8 Habitat - Turtles

Species	Juvenile Habitat	Adult Habitat
Atlantic Leatherback *(Dermochelys coriacea coriacea)*	n/a[1]	Summer and fall visitor
Loggerhead *(Caretta caretta caretta)*	Transit in summer and fall	occasional summer visitor
Kemp's Ridley (Atlantic Ridley) *(Lepidochelys kempi)*	During pelagic stage it drifts north on the Gulf Stream, only juveniles found off Nova Scotia.	n/a

[1]n/a = not found in study area during this life stage

Adult leatherback turtles are observed in Nova Scotia waters. They eat jellyfish and are vulnerable to mistaking plastics disposed at sea for their prey, a mistake that is often fatal. Preliminary results from recent research suggest that leatherbacks occupy foraging areas on the Scotian Shelf for extended periods of time before migrating south (James et al. in press). Less is known about the movements of the other two species. The loggerhead is found in both offshore and coastal areas while the Kemp's ridley is believed to prefer shallow water. Loggerheads likely migrate through eastern Canadian waters during the pelagic-juvenile stage. The Scotian Shelf is not believed to be important habitat for Kemp's ridleys as only two records exist for this species in Atlantic Canada (McAlpine 2001) All species are vulnerable to entanglement in fishing gear. It has been suggested that turtles may also be vulnerable to entanglement in seismic equipment and other petroleum infrastructure, although little is known.

2.3.6 Forage species for fish, mammals, and birds

All species rely on others lower on the food chain for their survival. In the study area, important forage species include sand lance, shrimp, zooplankton (such as krill) and the juveniles of numerous commercial fish species (such as herring). Sand lance constitute a major prey populations of over 100 consumer species. Included among these are 40 species of birds, 12 species of marine mammals, 45 species of fishes and some invertebrates (Robards et al 1999). A large population is concentrated in the shallow waters around Sable Island. The eggs and young of zooplankton are fed on by the youngest stages of fish and as fish grow the feed on the larger zooplankton (i.e. krill). Many fish species also feed heavily on the adult krill (DFO 2000e). Baleen whales also feed on krill, as do some marine birds. Krill are found predominantly in waters with depths greater than 200 metres, and migrate through the water column (Everson

2000). Other species of zooplankton are found throughout the study area. Habitat of sand lance and krill can be found in Table 9.

According to Sameoto et al. (2002), the Gully Trough, north of Sable Island Bank, appears to be particularly important for krill, which may in part explain why blue whales are regularly sighted here in August. For the Trough and the Gully area, lanternfish and squids (likely several species) are important forage species, in particular for the marine mammals found there.

Table 9 Habitat - Life Stages of Sand Lance and Krill[1]

Species	Spawning Within Study Area		Areas of Concentration of Adults within Study Area
	Period	Location in Study Area	
Fish			
Sand lance (*Ammodytes* sp.)	November to April	Sable Island Bank	Sable Island Bank, especially shoals around Sable Island
Invertebrates			
Krill (euphasiids)	April and May	throughout	Concentrated in shelf break area, depths of less than 200 m

[1] Sources consulted include the same references as Table 1.

2.3.7 Species at Risk

Each year, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) evaluates the status of wildlife across the country and produces a list of species considered to be at risk. Several such species are found on the Scotian Shelf, with a status of "endangered"(highest risk), "threatened" or "special concern" (COSEWIC 2000).

Endangered species include the blue whale (recently listed) northern right whale, the leatherback turtle and the roseate tern, which nests on Sable Island. Roseate terns breed in very few places and are vulnerable to habitat or environmental changes.

Threatened species include the harbour porpoise and two marine fish, the northern wolfish and the spotted wolfish.

Species of special concern include the fin, humpback, Sowerby's beaked and northern bottlenose whales (Gully population) that have been discussed earlier (See section 2.3.2).

Another species of concern is the Ipswich sparrow, a sub-species of the savannah sparrow found only on Sable Island. This sparrow is protected under the Migratory Bird Convention Act and Sable Island is recognised as a Migratory Bird Sanctuary. It would be threatened by any

onshore activities that destroy its nesting habitat. However, Kenchington (1997) suggested the sparrow could also be vulnerable to bright lights or other offshore activities that could prevent its finding its way to Sable Island during migration periods.

At present, the Atlantic cod is the only marine fish listed as a species of special concern. However, the barndoor skate and the cusk will be the subject of status reports in the year 2001. (Breeze 2002).

2.3.8 Special Areas

Three special areas associated with the study area are identified. :

- Sable Island (outside study area but high profile),
- Sable Gully and the Gully Trough, and
- Shortland and Haldimand Canyons.

There is a lack of knowledge about the important habitats of the Scotian Shelf. Although the SEA considers only those listed above, other important places could include undisturbed zones (such as deep water and areas with rough bottom characteristics), biologically productive zones (such as the shelf break), areas with high biodiversity, and areas that are representative of various habitats of the Scotian Shelf (CNSOPB 2000).

2.3.8.1 Sable Island

The elongated sandbar known as Sable Island lies approximately 300 kilometres southeast of Nova Scotia. Although it is outside the study area (eastern tip is approximately 19 kilometres west of the study area boundary), its high profile warrants acknowledgement in this SEA. The island is about 50 kilometres long by 3 kilometres wide, and has shifted over the years. It is the province's farthest offshore island and is a unique physical feature. Sable Island is valued by scientists because of its distinct features and therefore its environment has been thoroughly studied (Davis and Browne 1996). There is evidence to suggest that Sable Island was a refuge during glaciation for many species of invertebrates and there are distinct populations of several insect species.

The waters near Sable Island are the feeding grounds for many seabirds and marine mammals (see also sections 2.3.2 and 2.3.3). In addition to Ipswich sparrows and endangered roseate terns described previously (section 2.3.7), the island is home to 2500 breeding pairs of terns (about 60 percent Arctic), 500 pairs of black-backed gulls, 2000 pairs of herring gulls, as well as several species of waterfowl and shorebirds. The island is a Migratory Bird Sanctuary and is important to breeding seal populations, as discussed in section 2.3.2 above. Several whale species also live and feed in the waters around Sable Island.

At least six species of invertebrates are endemic to the island. Several species of butterflies and moths have been found on the island and not identified; they may also be endemic to the island. There are also about 300 wild horses living on the Island that were introduced in the 1700's.

Towards a Conservation Strategy for Sable Island (Beson 1998) discusses issues related to conservation on the island. The CNSOPB has regulated a one nautical mile "no-drilling" zone around the island. Other petroleum activities within that zone or on the island require the

operator to prepare a code of conduct that prohibits non-essential activities and limits others to specific areas or rights-of-way. Although this provides some protection for the island, the increasing number of petroleum industry-related activities (in combination with other activities such as tour operators and researchers) creates an increased chance of cumulative environmental impacts (CNSOPB 2001b).

2.3.8.2 Sable Gully and the Gully Trough

The Sable Gully is the largest canyon feature of the Scotian Shelf. The canyon and trough are considered a unique ecological feature of the Shelf; the canyon itself is about 40 kilometres long and 10 kilometres wide, reaching depths of more than 2000 metres (Harrison and Fenton 1998). The Gully provides important habitat for marine mammals, especially northern bottlenose whales (see section 2.3.2) and the area was declared a whale sanctuary by DFO in 1994 (DFO 1998a), in recognition of its importance as northern bottlenose whale habitat (see Appendix A for whale sanctuary coordinates). Parks Canada, in 1992, identified a large area that included both Sable Island and the Gully as a national area of Canadian significance with a high ranking for a potential protected area. Five of the eleven whale species commonly found in the Gully, and all those for which the Gully formed significant habitat on the Scotian Shelf, were found to be concentrated in the deep (200-2000 metres) mouth of the canyon (Hooker et al. 1999), although sperm whales are found in the upper portions of the Gully, in water as shallow as 200 metres, and blue whales feed in the trough at the head of the canyon.

As might be expected, the area is subject to intense scientific scrutiny. A notable contributor is the Whitehead Lab at Dalhousie University, which has published a large body of research literature. The Gully Scientific Review (DFO 1998a) describes the environment and processes of the Gully. An update of recent scientific research in the Gully area is found in Gordon and Fenton (2002). The Gully Trough has special area status due to important fisheries, cetaceans, diverse habitats, and connection with the canyon.

The panel reviewing the Sable Offshore Energy Project (SOEP) expressed concern regarding potential encroachment on the Gully by offshore oil and gas developments. It also suggested that further study of the Gully and adjacent areas should be carried out, in order to provide baseline data on the marine environment (Joint Review Panel 1997). In response to this, the CNSOPB, as a condition of its approval for the SOEP, required the proponents to prepare and submit a Code of Practice to protect Sable Island and the Sable Gully.

In 1998, DFO declared a portion of the Gully, referred to as the "core area", to be an Area of Interest (candidate Marine Protected Area) and restricted activities in a defined area of the Gully (see Appendix A for AOI coordinates), although the Gully ecosystem is larger than the canyon feature. The authority to establish Marine Protected Areas is provided in the *Oceans Act*, and is intended to provide a means to conserve and protect unique habitats, endangered or threatened marine species and their habitats, commercial and non-commercial fishery resources (including marine mammals) and their habitats, marine areas of high biodiversity or biological productivity, and any other marine resource or habitat requiring special protection. In Canada, and across the world, there is a growing recognition that Marine Protected Areas have a critical role to play in the conservation and protection of marine life and their habitats.

The Area of Interest selected for further assessment includes the deep canyon portions of the Gully, the Whale Sanctuary and a range of other important habitats valued for their biological communities. This is the first Atlantic Canadian MPA project with an entirely offshore focus. (Fenton et al.2000). The intent of pursuing an MPA designation for the Gully is to provide long-term protection for a key part of its ecosystem, including many of those features that make the

area ecologically significant. As specifically described in *The Sable Gully Conservation Strategy* (DFO, 1998e), the overall conservation objective is to "conserve and protect the natural biological diversity and integrity of the Sable Gully ecosystem to ensure its long-term health and sustainable use". This includes:

- Protecting and conserving valued 'keystone' and sensitive species and communities and their habitats;
- Planning for the 'multiple use' of the Sable Gully ecosystem, with activities in the area that meet the objective and goals of the Conservation Strategy; and,
- Providing a process that promotes and facilitates collaboration among agencies, users, and interests in the Sable Gully to help resolve and conflicts and to develop an open and inclusive dialogue.

The Canada-Nova Scotia Offshore Petroleum Board has not authorized any activities in the Gully AOI and has a policy prohibiting oil and gas activity in the Sable Gully and Whale Sanctuary area until further notice. In addition to the buffer around the core area of the Sanctuary, which is already included in the existing boundary, the Board requires that any seismic program proposed within ten (10) kilometres of the boundary be subject to an expanded individual assessment, as described in the Board's *Environmental Assessment of Seismic Exploration On the Scotian Shelf* (Davis et. al 1998).

2.3.8.3 Shortland and Haldimand Canyons

Submarine canyons in general are of increasing interest to scientists and conservationists because of the diverse habitat they contain within a relatively small area. Unlike the Gully, no detailed studies have been carried out on two nearby submarine canyons, Shortland Canyon (50 kilometres east of the Gully) and Haldimand Canyon (100 kilometres east of the Gully). They are more accurately described as "potential" special areas. Recent research on northern bottlenose whales indicates that these canyons may be of equal importance as the Gully to this whale population (Whitehead and Wimmer 2002). Whitehead and Wimmer (2002) also suggest that this region should receive consideration as a marine protected area, but research is continuing in order to confirm these findings.

These submarine canyons are also used by other cetaceans such as sperm whales, although their importance to cetaceans seems to be dependent on the presence or absence of other oceanographic features as well (Whitehead et al.1998).

Studies in analogous regions show that the benthic communities are more diverse and have greater abundance in canyons than in nearby slope areas (DFO 1998a). In Nova Scotia's offshore, it has been speculated that steep-sided submarine canyons may be less vulnerable to trawling activity and thus represent a less disturbed marine environment (Breeze et al. 1997).

Nova Scotia's submarine canyons may be important for deepwater sessile invertebrates such as corals and sponges. Both Shortland and Halidimand Canyons were identified by fishermen as sites where large, colonial corals were found at depths of 300 metres and deeper (Breeze et al. 1997). Gorgonian corals in museum collections were collected from these canyons and a 1998 research trawl survey carried back several species of deep water corals from Haldimand Canyon. Surveys of these canyons are needed to find out more about the benthic fauna that inhabit them, similar to the survey carried out by Hecker et al. (1980) in the United States.

3.0 Environmental Effects of Authorized Exploration Activities

Activities that could be authorized under an exploration licence are, as the name implies, those associated with exploration, typically geophysical (seismic) and exploratory drilling programs. One cannot accurately predict the number and extent of the activities, but based on experience, certain assumptions can be made. For example, by looking at the size of the study area compared to typical offshore parcels, it appears that up to five or six licences could be accommodated within the study area. Also based on experience, it is unlikely that all of these would be active simultaneously – activities would be spread over the full period of the licence. As previously explained, a licence holder must drill a well within the first five years, or surrender their interest in the land. An aggressive exploration scenario would see perhaps one geophysical survey per licence, or six surveys, in the first two to three years, with perhaps three wells arising from that, being drilled in the remainder of the initial five-year period. Due to limited availability of seismic vessels, operators often share the same vessel when it is in the area. Thus surveys tend to be conducted sequentially, as opposed to concurrently. However, the strategic EA considers a worst-case scenario to be two concurrent surveys per year in years one and two and three, followed by three simultaneous exploration wells in a single year.

For the purposes of predicting the significance of the effects, the methodology outlined in the generic assessments of seismic (Davis et al. 1998) and exploratory drilling (Thomson et al 2000) is applied. In summary, the estimated magnitude, scale, duration and likelihood are considered. Magnitude is rated as major, moderate minor, or negligible. Scale is regional, local, or sub-local. Duration is rated as either long-term, medium-term, or short-term. Effects are additionally rated as either likely or not likely. A significant effect is defined as one that is either a) major or moderate, or b) minor, but with a medium or long-term duration and regional scale. The terms are fully defined in the generic assessments.

3.1 Geophysical (Seismic) Surveys

There are currently few data from the Nova Scotia offshore about the environmental effects of seismic exploration. This is presently a topic of much study and discussion. However, a great deal of information is available, especially for other jurisdictions. The generic environmental assessment of seismic (Davis et al. 1998) provides detailed descriptions of the procedures and equipment used, summarizes the current state of knowledge based on the available literature, and offers expert opinion about the probable effects in the Nova Scotia situation. The generic assessment's conclusions pertaining to the VECs selected for this strategic assessment are presented in Table 3.1. Where no applicable conclusion exists, a reasoned estimate is presented. Overall, it is concluded that seismic surveys are not likely to cause significant adverse environmental effects.

Table 10 – Predicted Environmental Effects of Marine Seismic

Valued Ecosystem Component	Relevant Generic Assessment Conclusion(s)
Fish & Invertebrates of Commercial Importance, Including Larvae	• Direct impacts of seismic exploration on adult fish are predicted to be *negligible*. • Impacts on fish larvae, including those in nursery areas, would be *minor*, *sub-local* , *short-term* and *likely*. • Impacts on fish hearing are predicted to be *negligible* • Impacts on invertebrate behaviour and related impacts on

	fisheries are likely to be *negligible*. • Impacts on catch due to presence of the array and associated noise in typical shooting area are predicted to be *minor, sub-local, short-term* and *likely* to occur.
Whales	• The effects of seismic pulses on the long-finned pilot whale, common dolphin, Atlantic white-sided dolphin, white-beaked dolphin, striped dolphin and harbour porpoise would be *minor, sub-local, short-term* and *likely* to occur. If they occur, they would be limited to animals very close to the operating array. • The effects on sperm whales and northern bottlenose whales are predicted to be *negligible* to *minor, local, short-term* and *may occur.* • The predicted acoustic impacts on baleen whales (right, humpback, blue, fin, sei and minke) are judged to be *minor, local, short-term* and *likely* to occur.
Seals	• The impacts of seismic pulses on harbour and grey seals are judged to be *minor, sub-local, short-term* and *likely* to occur.
Marine Birds	• The effects of seismic exploration on birds in the Scotian Shelf Study area are expected to be *negligible*.
Benthic Invertebrates	• Direct physical impacts on invertebrates and their larvae are predicted to be *negligible*.
Turtles	• It is likely that seismic effects on sea turtle populations on the shelf will be *negligible*.
Forage Species for Fish, Mammals and Birds	• Impacts on invertebrate larvae and plankton as they relate to feeding by fish are predicted to be *negligible*.
Species at Risk	• Most species considered in conclusions for whales, turtles and fish. Exceptions are: Sowerby's beaked whale ('probable visitor' only, therefore effects unlikely), roseate tern and Ipswich sparrow (land-based, therefore unlikely to be affected by marine seismic).
Sable Island	• Not specifically evaluated in generic assessment. Sable Island is about 18 km outside the SEA study area and is therefore unlikely to be affected.
The Gully	• Not specifically evaluated in generic assessment, but no activity allowed in the AOI. Further protected by 10 km buffer zone in which detailed assessment is required. Therefore, effects unlikely.
Shortland and Haldimand Canyons	• Not evaluated in generic assessment. See mitigation discussion and conclusions.

Mitigation

The absence of any predicted major or moderate impacts means no significant adverse effects are likely. Regardless, mitigation would be applied as a precaution to further reduce the likelihood of adverse effects. Some important mitigation techniques, which are now standard practice and are discussed in detail in the generic assessment, are gradual increase of seismic energy (a.k.a. "ramping up") and scheduling to avoid sensitive times and locations, such as spawning areas. The latter technique could also be applied to avoid multiple surveys taking place in close proximity to one another at the same time. In any event, the Board does not allow unnecessary overlap in seismic surveys. Specific mitigation would be addressed during the program-specific assessment stage, when an authorization is being sought.

Monitoring

Seismic surveys in the Nova Scotia offshore currently require on-vessel observers. The observers' main role is liaison with fishing vessels in the area, but they also record any mammals or birds they observe in the area. It is likely this requirement will remain in place unless a suitable alternative is proposed.

3.2 Exploratory Drilling

There are currently few data from the Nova Scotia offshore about the environmental effects of exploratory drilling. However, a great deal of information is available. The generic environmental assessment of exploration drilling (Thompson et al. 2000) provides detailed descriptions of the procedures and equipment used, summarizes the current state of knowledge based on the available literature, and offers expert opinion about the typical probable effects of exploratory drilling. The generic assessment's conclusions pertaining to the VECs selected for this strategic assessment are presented in Table 3.2: Where no applicable conclusion exists, a reasoned estimate is presented. Overall, it is concluded that, with appropriate mitigation, exploratory drilling is not likely to cause significant adverse environmental effects.

Table 11 – Predicted Environmental Effects of Exploratory Drilling

Valued Ecosystem Component	Relevant Generic Assessment Conclusion(s)
Fish & Invertebrates of Commercial Importance, Including Larvae	• The presence of rig structures on fish behaviour will be *minor*, *short-term* and *sub-local*. This implies a *negligible* effect on fish. • The effects of rig safety exclusion zone on most elements of the fishery is predicted to be *minor*, *sub-local* and *short-term*. For certain fisheries, such as swordfish and shark, that use very long (up 70 km) drifting gear, the effective exclusion zone would have to be larger to insure that the gear did not drift into the drilling rig. In these instances, the impacts would be *minor*, *local*, and *short term*. • Effects of noise from supply vessels on fish behaviour will be *minor*, *local* to *sub-local* and *short-term*. This will translate into *negligible* impacts on individual fish, populations and fishery. • Impacts of noise from exploration platforms on fish and fish behaviour in the study area will be *negligible*. • The effects of cooling water and grey water / black water discharge will be *negligible*.

	• Impacts of treated oily waters (deck drainage, ballast water, bilge water and water produced during well testing) will be *negligible*.
Whales	• The potential impacts on baleen whales of individual passages by supply vessels during exploratory drilling operations are likely to be *minor*, *short-term*, and *sub-local* to *local*. Impacts on toothed whales may be similar; that is, *minor*, *short-term* and *sub-local* to *local*. • Low flying helicopters and fixed-wing aircraft could cause *minor*, *short-term*, and *sub-local* impacts on marine mammals in the water. With minimum-altitude mitigation, effects will be *negligible*. • Impacts of noise and disturbance from drilling operations on toothed and baleen whales would be *negligible* to *minor*, *sub-local* to *local*, and *short-term*. • The effects of cooling water and grey water / black water discharge will be *negligible*. • Impacts of treated oily waters (deck drainage, ballast water, bilge water and water produced during well testing) will be *negligible*.
Seals	• Impacts on seals of individual passages by supply vessels during exploratory drilling operations are likely to be *minor*, *short-term*, and *sub-local* to *local*. • Low flying helicopters and fixed-wing aircraft could cause *minor*, *long-term*, *local* impacts on seals at terrestrial haul-out sites. With minimum-altitude restrictions, effects will be *negligible*. • Impacts of noise and disturbance from drilling operations on seals, would be *negligible* to *minor*, *sub-local* to *local*, and *short-term*. • The effects of cooling water and grey water / black water discharge will be *negligible*. • Impacts of treated oily waters (deck drainage, ballast water, bilge water and water produced during well testing) will be *negligible*.
Marine Birds	• Overall, the presence of structures is expected to have a *negligible* effect on marine and terrestrial birds. • The effect on seabirds attracted to lights and flares on drill rigs and supply boats is predicted to be *minor*, *short-term* and *sub-local* to *local*. • Noise and disturbance from normal offshore ship operations will have a *negligible* effect on sea-associated birds in offshore waters. • There is potential for *minor* to *moderate*, *local*, *medium-term* effects on seabird colonies if disturbed by ships. Minimum distance restrictions (2 km) will render effects *negligible*. • Impacts of low-level aircraft will be *negligible* to *minor*, *short-term* and *sub-local*. If unmitigated, effects on bird colonies could be *moderate* to *major*, *local* and *long term*, thus altitude and routing mitigation measures will be used to ensure effects are *negligible*. • Overall, acoustic impacts on marine and terrestrial birds caused by the presence of drill rigs would be *negligible*. • The effects of cooling water and grey water / black water discharge will be *negligible*. • Impacts of treated oily waters (deck drainage, ballast water,

	bilge water and water produced during well testing) will be *negligible*.
Benthic Invertebrates	• The discharge of cuttings and water based muds are predicted to have *minor*, *sub-local*, *medium-term* impacts on benthic communities.
Turtles	• Not specifically addressed, but generic assessment suggests effects would be similar to or less than for other species.
Forage Species for Fish, Mammals and Birds	• Not specifically evaluated in generic assessment. Not expected to be significant, based on lack of predicted significant effects on fish, invertebrates and larvae.
Species at Risk	• Not specifically evaluated in generic assessment. In general, effects on fish, mammals and birds are not predicted to be significant. Short duration of drilling activity limits chance of interaction with species at risk.
Sable Island	• Not specifically evaluated in generic assessment. Sable Island is about 18 km outside the SEA study area and is therefore unlikely to be affected.
The Gully	• The effects of drilling waste on deep-sea corals would be *minor*, *sub-local* and *short-term*. Predicted effects on whales, as described above range from *negligible* to *minor*, *short-term*, and *sub-local* to *local*.
Shortland and Haldimand Canyons	• The effects of drilling waste on deep-sea corals would be *minor*, *sub-local* and *short-term*. Predicted effects on whales, as described above range from *negligible* to *minor*, *short-term*, and *sub-local* to *local*.

Oil Spills

The above table does not include the effects oil spills. A large oil spill (e.g. blow-out), could cause significant adverse environmental effects, but has a low probability of occurrence, meaning that significant adverse effects are unlikely. Smaller spills, typically several litres or less, tend to occur more frequently, but are generally of insufficient magnitude to cause significant effects. Technology and safeguards are in place to prevent a blow-out, while other spills are avoided to the extent possible through pollution prevention measures incorporated into environmental protection plans (required for all drilling programs). Regardless, emergency response plans are required for various situations, including oil spills.

Mitigation

With appropriate mitigation, drilling programs are unlikely to cause significant adverse environmental effects. The absence of any predicted major or moderate impacts means no significant adverse effects are likely. Regardless, mitigation would be applied as a precaution to further reduce the likelihood of adverse effects. Many mitigation measures are built into project design. Some are legislated and others are part of modern oil exploration equipment and/or operating procedures that have been designed with due regard for environmental protection. Still other mitigation measures are enforced by policy, such as the Gully prohibition. All waste discharges will comply with the Offshore Waste Treatment Guidelines (OWTG), thereby minimizing the adverse effects of wastes from drilling operations. The OWTG describe minimum standards for the treatment and/or disposal of wastes associated with the routine operations of drilling and production installations offshore Canada. Under the OWTG, offshore operators are also mandated to continually strive to reduce both the volumes of wastes being

discharged and the concentrations of contaminants. The generic assessment describes other mitigation which can be employed on a project specific basis, such as vessel and aircraft routing restrictions using established procedures for safe release of stranded birds attracted to rig lights and avoidance of sensitive times and features such as corals. Specific mitigation requirements would be addressed during the program-specific assessment stage, when an authorization is being sought. For example, drilling near the Gully may require stricter waste controls than those specified in the OWTG.

Monitoring

Exploration drilling projects currently require compliance monitoring. Monitoring of environmental effects would be considered on a case-by-case basis depending on the location and timing of the drilling program.

4.0 Cumulative Effects

Cumulative effects analysis is an emerging discipline that has been the focus of considerable discussion in recent years (Hatch et al. 2000). In the context of this strategic environmental assessment, cumulative effects may arise from the additive effects of oil and gas and other human activities, of which fishing and shipping are considered the two most prevalent. A brief summary of these activities is provided, followed by a discussion.

4.1 Oil and Gas Activities

Past Oil and Gas Activities

Five wells have been drilled within the study area. These are Missisauga H-54 (1970), Bluenose G-47 (1973), Bluenose 2G-47 (1982), Peskowesk A-99 (1984) and Citadel H-52 (1984). MicMac D-89 (1976), MicMac H-86 (1970), MicMac J-77 (1970), Chippewa G-67 (1971), Chippewa L-75 (1971), Sauk A-57 (1971), Banquereau C-21 (1982), N. Banquereau I-13 (1982), South Griffin J-13 (1984) and Tantallon M-41 (1986) are wells in close proximity to the study area. There were also three wells drilled on the Primrose Significant Discovery – Primrose N-50 (1972), Primrose 1aA-41 (1972) and Primrose F-41 (1973). Primrose is located mostly in what is now the Gully AOI. As can be seen from the years drilled, none of these is worthy of consideration with respect to cumulative effects, the most recent occurring eighteen years ago.

There were seven (7) seismic surveys undertaken over the Scotian Shelf and Slope in 2001. In addition, there were two hundred and fifty (250) programs undertaken between 1969 and 2000. These programs ranged from a single line to broad surveys of the Scotian Shelf, to more intensive surveys around Sable Island. Most programs were conducted from 1980 to 1984 with a prior cluster of activity in the early 1970's.

Details of historic exploration activities can be found in CNSOPB's *Information on Well Data, Geological Data, Geophysical Data and Land Rights*.

Current Oil and Gas Activities

At the time of this writing, there are currently no exploration licences within the study area and therefore no oil and gas drilling activities there. There are four wells being drilled, or recently suspended/abandoned, elsewhere on the Scotian Shelf at the time of this writing (Annapolis G-

24, Venture 6, Newburn H-23, and Marquis L-35). None of these wells are close enough (approximately 27, 60, 130 and 115 kilometres, respectively) to have a zone of influence reaching the study area.

The Sable Offshore Energy Project is currently operating to the west of the study area. The easternmost satellite platform, Venture, is about 10 kilometres away from the study area's western boundary. Another satellite platform (North Triumph) is about 25 kilometres away, while the Thebaud main processing platform is even further west, approximately 30 kilometres away from the study area. Ongoing monitoring has revealed no measurable environmental effects beyond 500 metres of the platforms, and most detections are limited to 250 metres or less. Thus, the effects of the Sable Offshore Energy Project are negligible with respect to the study area. A blowout would probably change this situation, but the event is unlikely.

Future Oil and Gas Activities

ExxonMobil is currently proceeding with Tier 2 of the Sable Offshore Energy Project, which involves developing and connecting the Alma, Glenelg and South Venture fields. The effects and distances of these three operations will be similar to those of Venture and North Triumph and are thus of limited concern to the study area.

Encana Resources is in the regulatory approval process for its Deep Panuke Offshore Gas Development. This project, expected to have similar effects to the Sable project, will be located further west and its normal operations will therefore not result in environmental effects with implications for the study area.

There is currently a seismic program proposed by GSI that touches the northern boundary of the Gully AOI. Marathon Oil is currently planning a 3D seismic acquisition program for 2002 for its exploration licenses 2410 an 2411, which abuts the study area to the south. As well, Encana Resources proposed 2002 Stonehouse 3D seismic program touches the southeast corner of the Haldimand Canyon portion of the study area, coming within 10-15 kilometres of the canyon itself.

There are no other known planned projects in the vicinity of the study area at this time.

4.2 Other Human Activities

A number of other activities could act synergistically with oil and gas exploration. By far the two most significant of these are fishing and shipping.

4.2.1 Fisheries

Current Fisheries

The north-eastern sections of Sable Island Bank and Banquereau Bank have seen fishing activity for groundfish species greatly reduced in the last few years, although some groundfish are landed from that area, along with fishery on the Sable Island Bank for deep-sea scallops.

The snow crab fishery is expanding throughout deeper waters of eastern Cape Breton as far as Banquereau Bank. There is an Arctic surfclam fishery located on Banquereau Bank, as well as a small Iceland scallop fishery. Northern propeller clam and ocean quahuag are caught and processed as a by-catch of the Arctic surfclam (Mactromeris polynyma) fishery. The area is

considered to have some Arctic surfclam potential, with tows done mostly in depressions and crevasses in the Trough (GTA Consultants 1999).

The Gully and adjacent waters is an area of relatively high demersal finfish diversity relative to the eastern Scotian Shelf (DFO 1998a). Although not considered unique or exceptional for most fisheries, the region is considered important to commercial fishing. Active fisheries are carried out for halibut, swordfish and silver hake as well as fisheries for tuna (bluefin, albacore, yellowtail, and big-eye) and shark (porbeagle, mako, and blue).

Halibut long-lining is one of the most lucrative fisheries in the Gully area. Two of the main fishing areas are the South West Peak (Banquereau Bank) and Gilligan's Island (Gully Trough). Swordfish and tuna (albacore, bigeye and yellow fin) are caught primarily along the Shelf break and across the mouth of the Gully. Sharks (porbeagle, blue and mako) are fished mainly along the edge of Scotian Slope, although catches in the Gully area are not high.

Other fisheries include a silver hake fishery on the Slope, crab, particularly in the Trough area, a halibut fishery which also takes place in upper feeder canyons. There is also a significant halibut and swordfish fishery in Shortland and Haldimand canyons. The halibut fishery is particularly important to the community of Sambro.

Developing Fisheries

With the decline in abundance of historically utilized species, other finfish are becoming more important to the fishing industry. Monkfish, formerly considered a bycatch, has been increasingly targeted by fishermen (DFO 1996). There are found in a wide range of depths. Fisheries have been carried out for argentine and grenadier in the deeper waters along the shelf edge and slope.

Pohle et al. (1992) reviewed deepwater species that have the potential to become commercially exploitable. Although this report did not find strong evidence for the presence of any significant resource with immediate development potential, a few species exhibited encouraging signs, that they might be able to support fisheries. The most promising species included Atlantic saury (*Scomberesox saurus*), blue hake (*Antimora rostrata*), and black scabbardfish (*Aphanopus carbo*) while black dogfish (*Centroscyllium fabricii*) and orange roughy (*Hoplostethus atlanticus*) were thought to have less potential. These species occur in the slope area and may become increasingly important.

Capelin had been found since the mid-1980s on the Eastern Scotian Shelf and there have been discussions of a directed fishery (DFO 1997a). Among invertebrates, ocean quahog is not currently being harvested on offshore banks but there are potentially exploitable stocks on Sable Island Bank and Banquereau Bank (DFO 1998b). Quahogs are found in shallower waters on sandy bottom. There is potential to expand the snow crab fishery in the Gully area (GTA Consultants 1999).

Several other invertebrate species may have potential for commercial development, such as the sea cucumber and the northern propeller clam. There are potential stocks of northern propeller clams on Banquereau and Western/Sable Bank. There are currently applications under review to develop directed fisheries for the northern propellerclam and ocean quahog on the Scotian Shelf. There was formerly a directed fishery for squid on the Scotian Shelf. Squid is presently primarily a by-catch, although it is believed to be abundant throughout the shelf (CNSOPB 2000). There are two species of squid, shortfin (*Illex illecebrosus*) and longfin *(Loligo pealei*). An exploratory red crab fishery caught some crabs in the Gully.

Pohle et al. (1992) identified the scarlet shrimp (*Plesiopenaeus edwardsianus*), northern stone crab (*Lithodes maja*), porcupine crab (*Neolithodes grimaldi*) as well as spiny lobsterette (*Munida valida*) and the smoothridged blind lobster (*Stereomastis sculpta*) as having some potential for commercial exploration. The Gully area appears to have a relatively high concentration of stone crab, given the results of exploratory trap fishing and groundfish surveys. Porcupine crab is restricted to deeper waters, generally greater than 300 metres water depth (DFO 1998, p.171).

Toad crab, Jonah crab, and rock crab are species of interest in this area. Exploratory fishing for lobsters has recently been conducted to the east of the study area.

4.2.2 Shipping

Several of the major trans-Atlantic shipping routes pass near the Gully with the main shipping lane situated about 30 km south of the area. Increasing petroleum exploration or development activity on the Scotian Slope will enhance the probability of interactions with shipping traffic. Although difficult to assess, the actual number of vessels passing through the area on a monthly basis is considered to be quite small. The Notice to Mariners issued in 1994 to avoid the DFO Whale Sanctuary in the Gully is thought to have reduced shipping traffic to a minimum. Most commercial vessels that cross the Scotian Shelf to enter Canadian ports typically pass well to the south or north of the Gully on routes plotted to give Sable Island – the "graveyard of the Atlantic" a wide berth (Fenton et al. 2000).

4.3 Cumulative Effects Discussion

The Department of Fisheries and Oceans has raised concerns about the cumulative effects of petroleum licences in the same area (DFO 1997b). While the impacts of a single, accident-free oil and gas project may be of little or no significance; the cumulative impacts of several projects may result in measurable detrimental impacts to some species and ecosystems. Location and timing restrictions are means of mitigating cumulative effects arising from seismic or exploratory drilling programs.

At present, little is known about the cumulative impacts of human activity on the Scotian Shelf, although an ongoing Environmental Studies Research Fund (ESRF) study is developing priorities and field monitoring programs for the eastern Scotian Shelf and Grand Banks. LGL Ltd. and Malme (2000) state it is likely that, to date, offshore industrial development on the Scotian Shelf has not affected the abundance of northern bottlenose or sperm whales present there. However, they stress that more research is needed in documenting the behavioural responses and hearing sensitivities of these animals to continuous sounds. The ESRF is also funding the acquisition of air monitoring equipment for the Sable Island station to monitor the cumulative effects of emissions from the offshore petroleum industry on air quality (CNSOPB 2001b). This air quality station is expected to be operational by the end of 2002.

The Nova Scotia offshore area has a history of petroleum exploration dating back more than 30 years. In recent years, the eastern part of Sable Island Bank and the entire Scotian Shelf edge and slope have again become the focus of interest for oil and gas exploration offshore Nova Scotia. This could have long-term cumulative effects on the species that use those environments and on other resource users. Although habitat sensitivity is important, it has not been the only criteria suggested for limiting human activity. Representivity is often considered an important factor in selecting areas for protection, and this concept has been used by agencies such as Parks Canada in selecting potential National Parks and National Marine

Parks. The Department of Fisheries and Oceans will likely adopt a combination of representivity and ecological importance in developing an integrated management plan for the eastern Scotian Shelf, and is in the early stages of identifying areas which may be considered as candidate marine protected areas (CNSOPB 2000).

In terms of fisheries, those that are concentrated in particular areas would be most likely to be affected by activities of the oil and gas industry. Halibut, swordfish and Jonah crab are also highly focussed on the Scotian Slope and Shelf break areas. Interaction between fishing vessels and seismic and other activities is inevitable in areas where activities are highly concentrated. The CNSOPB's requirement for advanced communication with potentially affected gear types, more pro-active consultation by industry at the planning stages of a seismic operation, and the use of observers on seismic vessels will help to minimize gear conflicts (CNSOPB 2000).

Cumulative impacts are a particular concern where they may encroach on identified valued areas, such as the Gully and Sable Island. The Gully Science Review found that available evidence suggested the Gully/Sable Island area is the most important habitat for both cetaceans and pinnipeds on the Scotian Shelf (Harrison and Fenton 1998). Recent research has revealed the Shortland - Haldimand Canyon areas to be important habitat for cetaceans, especially northern bottlenose whales. Any increase in exploration and development in that vicinity, even if it does not directly encroach on Sable Island or the Gully area, could have repercussions for the fauna that depend on these areas.

The marine environment is dynamic and constantly changing, characterized by species migrating vast distances along the shelf edge, and seasonal movements of species around and between the fishing banks. Although it remains difficult to predict the overall effects that petroleum exploration and development may have in the region, cumulative impacts cannot be ignored. Migratory species may be just as susceptible to cumulative effects as other species if they are migrating through exploration or drilling areas. Increased petroleum activity, in combination with other uses of the offshore such as fishing and shipping, would ultimately lead to greater stress on the marine environment.

5.0 Conclusions and Recommendations

In general, and based on current knowledge, properly mitigated seismic survey and exploratory drilling programs in the study area are unlikely to cause significant adverse environmental effects. Therefore, the issuance of exploration rights can be considered. For individual project assessments, depending on timing and location, special precautions may be required. Until a project is proposed for authorization, precise requirements cannot be identified. From a strategic perspective, for example, drill sites in proximity to corals may require discharge modeling to examine potential for local impacts, with mitigation designed based on the modeling results. This also means that operators would be required to gather information about the local environment so that potentially affected features could be identified. Mitigation could include a "no marine discharge" requirement, or re-locating the well site.

The Shortland Canyon – Haldimand Canyon portion of the study area has been recently identified as important habitat for the northern bottlenose whale population that also inhabits the Gully. If exploration licences are issued within this area, this will be considered in project-specific assessments prior to work authorizations being granted, with mitigation identified as appropriate. It is recommended that northern bottlenose whales be included as a Valued Ecosystem Component in environmental assessments of projects planned near these canyons.

There are also several important habitats found in waters near the study area. Some factors to be concerned about are species of groundfish that spawn on Sable Island Bank and Banquereau Bank. Seismic activities during spawning periods should be carefully planned to minimize impacts. For example, exact timing or survey tracks may require modification to avoid known spawning activity. Other areas of concern include deep-sea corals known to occur in several nearby areas, the proliferation of marine mammals that use the slope as a migration corridor, and pelagic seabirds found year-round in the Slope environment. The entire study area lies in close proximity to the Gully, a DFO Area of Interest (candidate marine protected area); assessment of any proposed activities must take this into account and identify the Gully as a Valued Ecosystem Component.

Due to the lack of knowledge of deep-water communities on the Scotian Slope, additional detailed information should be gathered by operators regarding deep-water benthic populations, prior to issuing any exploration licences in this area. Of particular concern is the effects underwater disturbances may have on these organisms. On a broader perspective, other issues which need to be examined more closely include sediment transport processes between Sable Island Bank and the Gully feeder canyons as well as ocean current patterns within the Gully that result in the transport of materials onto and off the surrounding shelf area. If seismic exploration is to occur close to the Gully, then the program-specific assessment required should consider research initiatives to address the question of effects on the sperm whale and the northern bottlenose whale, and enhanced mitigation measures to reduce the likelihood, extent and severity of effects. In general, more information is needed about effects on species at risk, distribution of red crab, stone crab, lobster, other crustaceans and non-commercial fish species, recruitment links between the Gully and the rest of the Scotian Shelf and fish and invertebrate movement between the Gully and the Scotian Shelf. Some of the unknowns are difficult and time-consuming questions to answer. To the extent practical, they will be addressed in project-specific environmental assessments, but they may need to be more fully explored in forums such as the Environmental Studies Research Fund (ESRF), or the Panel on Energy Research and Development (PERD).

It cannot be assumed that effects of petroleum activities on the continental shelf would be similar to those that might occur on the Slope environment. Therefore, more details about specific communities in areas where activities may be undertaken is needed for subsequent project-specific assessments and for future strategic environmental assessments in other areas, or for assessments of cumulative impacts of petroleum exploration and development on the Scotian Shelf and nearby areas. Overall, the eastern Scotian Shelf (including most of the study area) has received far less attention than other portions of the Scotian Shelf. As a result, many of its features are still not well known.

Petroleum exploration activities are going through the early stages of a third active period (the early 1970's and early 1980's being the previous two) off Nova Scotia's east coast, yet thorough surveys of marine habitat have not been undertaken and attempts at marine habitat classification are still ongoing. The Department of Fisheries and Oceans is currently working on an Eastern Scotian Shelf Integrated Management (ESSIM) Project with various stakeholders. Marine Protected Area planning for the Scotian Shelf is also ongoing. Results from these processes could provide information that will be useful when designing mitigation and may identify other areas of Nova Scotia's offshore that could be sensitive to certain types of petroleum-related activity (CNSOPB 2000). Operators are expected to keep abreast of these activities and apply all available knowledge when conducting environmental assessments.

It is clear that we do not know all the answers. Certainty may not be achievable, but just as mitigation is applied as a precaution regardless, so too there is an obligation to continually strive

to improve our knowledge. The number of nearby offshore petroleum licences makes cumulative impacts an important issue that should be examined more closely.

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Appendix A - Coordinates

Study Area Boundary

Point	Latitude	Longitude	Lat Deg	Lat Min	Lat Sec	Lon Deg	Lon Min	Lon Sec
1	44.5000	-59.5000	44	30	0	-59	-30	-0
2	44.5000	-58.7500	44	30	0	-58	-45	-0
3	44.1667	-58.7500	44	10	0	-58	-45	-0
4	44.1667	-58.6000	44	10	0	-58	-36	-0
5	44.1500	-58.6000	44	9	0	-58	-36	-0
6	44.1500	-58.5250	44	9	0	-58	-31	-30
7	44.1667	-58.5250	44	10	0	-58	-31	-30
8	44.1667	-58.4750	44	10	0	-58	-28	-30
9	44.1833	-58.4750	44	11	0	-58	-28	-30
10	44.1833	-58.4500	44	11	0	-58	-27	-0
11	44.2000	-58.4500	44	12	0	-58	-27	-0
12	44.2000	-58.5000	44	12	0	-58	-30	-0
13	44.2500	-58.5000	44	15	0	-58	-30	-0
14	44.2500	-58.0000	44	15	0	-58	-0	-0
15	44.3333	-58.0000	44	20	0	-58	-0	-0
16	44.3333	-57.7500	44	20	0	-57	-45	-0
17	44.1667	-57.7500	44	10	0	-57	-45	-0
18	44.1667	-58.2500	44	10	0	-58	-15	-0
19	44.0000	-58.2500	44	0	0	-58	-15	-0
20	44.0000	-58.5000	44	0	0	-58	-30	-0
21	43.0000	-58.5000	43	0	0	-58	-30	-0
22	43.0000	-58.8750	43	0	0	-58	-52	-30
23	43.5500	-58.8750	43	33	0	-58	-52	-30
24	43.5500	-59.2000	43	33	0	-59	-12	-0
25	43.5833	-59.2000	43	35	0	-59	-12	-0
26	43.5833	-59.5750	43	35	0	-59	-34	-30
27	43.7667	-59.5750	43	46	0	-59	-34	-30
28	43.7667	-59.5000	43	46	0	-59	-30	-0
29	43.8833	-59.5000	43	53	0	-59	-30	-0
30	43.8833	-59.5500	43	53	0	-59	-33	-0
31	43.9667	-59.5500	43	58	0	-59	-33	-0
32	43.9667	-59.5250	43	58	0	-59	-31	-30
33	44.0167	-59.5250	44	1	0	-59	-31	-30
34	44.0167	-59.4500	44	1	0	-59	-27	-0
35	44.0500	-59.4500	44	3	0	-59	-27	-0
36	44.0500	-59.4750	44	3	0	-59	-28	-30
37	44.0667	-59.4750	44	4	0	-59	-28	-30
38	44.0667	-59.4500	44	4	0	-59	-27	-0

39	44.1167	-59.4500	44	7	0	-59	-27	-0
40	44.1167	-59.5750	44	7	0	-59	-34	-30
41	44.1667	-59.5750	44	10	0	-59	-34	-30
42	44.1667	-59.6000	44	10	0	-59	-36	-0
43	44.1833	-59.6000	44	11	0	-59	-36	-0
44	44.1833	-59.6250	44	11	0	-59	-37	-30
45	44.2000	-59.6250	44	12	0	-59	-37	-30
46	44.2000	-59.6500	44	12	0	-59	-39	-0
47	44.2167	-59.6500	44	13	0	-59	-39	-0
48	44.2167	-59.7250	44	13	0	-59	-43	-30
49	44.2500	-59.7250	44	15	0	-59	-43	-30
50	44.2500	-59.5000	44	15	0	-59	-30	-0
51	44.5000	-59.5000	44	30	0	-59	-30	-0

Whale Sanctuary

Point	Description	Latitude	Longitude	Lat Deg	Lat Min	Lat Sec	Lon Deg	Lon Min	Lon Sec
1	North tip of Whale Sanctuary	44.200000	-59.133333	44	12	00.00	-59	-08	-00.00
2	NW corner	43.900000	-58.800000	43	54	00.00	-58	-48	-00.00
3	SW corner	43.700000	-59.133333	43	42	00.00	-59	-08	-00.00
4	SE corner	43.700000	-58.800000	43	42	00.00	-58	-48	-00.00

Sable Gully Area of Interest

Point	Description	Latitude	Longitude	Lat Deg	Lat Min	Lat Sec	Lon Deg	Lon Min	Lon Sec
1	North line of 300 m contour	44.169416	-59.069976	44	10	9.90-	59	-04	-11.91
2	West line of 300 m contour	44.142738	-59.040241	44	08	33.86	-59	-02	-24.87
3	West line of west add-on	44.063607	-59.284109	44	03	48.99	-59	-17	-02.80
4	NE corner of 300 m contour	44.169360	-59.040449	44	10	09.70	-59	-02	-25.62
5	North tip of Whale Sanctuary	44.200000	-59.133333	44	12	00.00	-59	-08	-00.00

6	NW corner of 300 m contour	44.169473	-59.099504	44	10	10.11	-59	-05	-58.22
7	SW corner of 300 m contour	44.116116	-59.040034	44	06	58.02	-59	-02	-24.12
8	NW corner of Whale Sanctuary	43.900000	-58.800000	43	54	00.00	-58	-48	-00.00
9	Point in north tip of small gully to west	43.899453	-58.720473	43	53	58.04	-58	-43	-13.71
10	Point on west side of small gully to west	43.887457	-58.693257	43	53	14.86	-58	-41	-35.74
11		43.844055	-58.658940	43	50	38.61	-58	-39	-32.19
12		43.816836	-58.642321	43	49	00.62	-58	-38	-32.36
13		43.762400	-58.630075	43	45	44.65	-58	-37	-48.28
14		43.688341	-58.648444	43	41	18.04	-58	-38	-54.41
15		43.640867	-58.688679	43	38	27.13	-58	-41	-19.25
16		43.607315	-58.768713	43	36	26.34	-58	-46	-07.38
17		43.595603	-58.832127	43	35	44.18	-58	-49	-55.67
18		43.601617	-58.899477	43	36	05.83	-58	-53	-58.13
19		43.603833	-58.940150	43	36	13.81	-58	-56	-24.55
20		43.607315	-58.963329	43	36	26.34	-58	-57	-48.00
21		43.615221	-59.000065	43	36	54.80	-59	-00	-00.23
22		43.623774	-59.021058	43	37	25.60	-59	-01	-15.81
23		43.632954	-59.042050	43	37	58.64	-59	-02	-31.38
24		43.651946	-59.073539	43	39	07.01	-59	-04	-24.74
25		43.666507	-59.097155	43	39	59.43	-59	-05	-49.76
26		43.675370	-59.113337	43	40	31.34	-59	-06	-48.01
27		43.685816	-59.124270	43	41	08.95	-59	-07	-27.37
28	SW corner of Whale Sanctuary	43.700000	-59.133333	43	42	00.00	-59	-08	-00.00
29	Intersect of N 44 Lat with Whale Sanctuary	43.999976	-59.133398	43	59	59.91	-59	-08	-00.23

30	SW corner of western add-on to Whale Sanctuary	44.017673	-59.265507	44	01	03.62	-59	-15	-55.83
31	NW point of west add-on to Whale Sanctuary	44.109542	-59.302712	44	06	34.35	-59	-18	-09.77